Health Building Note 6

MC0064

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Radiology department

NHS Estates

An Executive Agency of the Department of Health

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Radiology department

London HMSO

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First published 1992

ISBN 0 11 321407 3

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About this publication

The Health Building Note series is intended to give advice on the briefing and design implications of Departmental policy.

These Notes are prepared in consultation with representatives of the National Health Service and appropriate professional bodies. Health Building Notes are aimed at multidisciplinary teams engaged in:

- designing new buildings;
- adapting or extending existing buildings.

Throughout the series, particular attention is paid to the relationship between the design of a given department and its subsequent management. Since this equation will have important implications for capital and running costs, alternative solutions are sometimes proposed. The intention is to give the reader informed guidance on which to base design decisions.

Health Building Note 6

Health Building Note (HBN) 6 focuses on diagnostic and supporting facilities needed in a radiology department. The accommodation includes:

- diagnostic rooms;
- computed tomography (CT);
- ultrasound;
- nuclear medicine.

It also gives facilities for therapeutic procedures, as appropriate.

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1.0 Scope of Health Building Note 6

Introduction

1.1 This Health Building Note (HBN) supersedes Health Building Note 6 – 'Radiodiagnostic department', published in 1985.

Purpose of the department

1.2 The purpose of a radiology department is to provide facilities for the investigation and treatment of patients by means of radiological and complementary techniques. Investigations and procedures are selected by a radiologist, often in consultation with the clinician supervising the patient's care. Radiology departments carry out investigations and report on the results as quickly as is reasonably practicable. In an acute general hospital they accept referrals from other departments in the same hospital including day surgery, from other hospitals, primary health care and community health team doctors.

1.3 For many years there has been an increasing demand for radiological and other procedures involving imaging and it is anticipated that this trend will continue in the future. Technological advances and innovations in imaging may produce changes in radiological methods but it is unlikely that these will significantly affect the increasing need. Radiology now has a greater role in the total management of the patient, involving consultation, diagnostic procedures, discussion and treatment. A well-designed radiological department is essential if patients are to be investigated and treated speedily and efficiently.

1.4 This Note provides guidance which covers a wide range of design options; the most effective use of the Note depends on full, early and continuing consultation with future users of the department. Attention should be given to any developments which may occur in the interval between design briefing and commissioning. There will be planning implications resulting from changes in practice, such as the increasing use of ultrasound and the increasing number of interventional procedures undertaken, with extra space needed for nursing preparation and support. This trend is expected to continue.

Inclusions

1.5 Guidance is given on the planning and design of radiology departments for a district service where the normal range of radiological and related procedures in routine use at general acute hospitals are to be employed. Since the last edition of this HBN, ultrasound, computed tomography and nuclear medicine imaging have become standard (see paragraphs 3.25–3.34).

Exclusions

1.6 This Note does not give guidance on:

a. the planning of rooms for highly specialised complex radiological equipment which is more appropriate to specialised units, for example regional cardio-thoracic and neuro-surgical centres. The clinical procedures likely to be undertaken in such centres will require control of air movement within the rooms and associated service spaces, to ensure that airborne bacterial contamination is diluted and its transfer from less clean to cleaner areas is minimised. This will require a more stringent and costly provision for ventilation than is appropriate for the imaging rooms described in this Note;

b. teaching facilities. When teaching facilities are to be provided, a separate case will need to be made for the cost of any additional accommodation needed for trainee radiologists or radiography students (see the Department of Health's DS letter 65/74 about teaching hospital space requirements, issued in March 1974). The Royal College of Radiologists and the College of Radiographers should be consulted at the initial planning stages for any radiology department where it is envisaged that radiologists and student radiographers will be undergoing training. Additional guidance is given in a booklet issued in 1986 by the University Grants Committee entitled "University Building Projects: Notes on Control and Guidance for Medical Projects";

c. filmless techniques and the digitalisation of images: these are under active development and their planning implications are not yet clear, but some comments are included, where appropriate;

d. Magnetic Resonance Imaging (MRI);

e. facilities for mobile Computed Tomography (CT) or MRI units at hospital sites;

f. mammography for population screening;

g. radiotherapy.

Range of provision

1.7 The facilities referred to in this Note reflect current policies in radiology. New space requirements arising from such policies and the development of new techniques have been provided as economically as possible. The Departmental Cost Allowances reflect the new provision (see Chapter 6). For a specialty in which technical advances are to be expected, it is essential that planning should allow flexibility in the use of all

diagnostic rooms, as the purpose of these rooms and the equipment may change many times in their life. Larger departments will have bigger demands for specific procedures and several small dedicated rooms may make a more efficient use of space than a few of the larger general purpose rooms.

1.8 All diagnostic rooms should preferably have natural lighting and be mechanically ventilated with options for air cooling in Computed Tomography (CT), ultrasound and fluoroscopy special procedures rooms. Waste anaesthetic gas scavenging should be provided for the special procedures rooms, as it is envisaged that general anaesthetics will normally be given only in these rooms. It is particularly important to consider the movement of equipment during installation and any later replacement. Appendix 5 discusses various methods for the construction of floors to minimise disruption to the smooth running of the department. To allow for flexibility in the provision of ceiling-mounted diagnostic equipment a structural, modular steel grid is recommended (see paragraph 3.35).

1.9 It is essential to provide a current image store within the radiology department: archival storage may be remote. Whole hospital policies will determine if, and at which stage, images will be miniaturised for storage. This decision should be made at an early planning stage (see also paragraphs 2.13–2.14).

1.10 Sorting and collating of both films and reports are matters of major importance and will require appropriate space.

1.11 It is assumed that all departments will use daylight automatic processing for normal purposes, although in each there may be one or more processors needing a darkroom for special processing requirements. Mechanical ventilation should be provided in all spaces containing film processing and silver recovery equipment, to deal with potentially harmful emissions of chemical fumes during use (see paragraph 5.34).

1.12 Much of the work undertaken in a radiology department makes use of ionising radiation. The statutory requirements and building implications of such techniques need to be understood by those involved in designing departments so that facilities can be planned to ensure the safety of patients and staff. To assist project teams, descriptions of a range of radiological techniques are given in Appendix 2.

Diagnostic work outside the department

1.13 In a normal acute general hospital, some investigations will take place outside the main radiology department, for example using mobile apparatus on the wards and in the theatres. There may also be departments in smaller hospitals serviced by the main one, which can place a heavy additional load on the supporting services of the main department, and appropriate provision should be made.

Future policy

1.14 Radiological practice and technical advances are evolving so rapidly that it is the intention to issue, from time to time, Supplements to this Note.

Capricode

1.15 Capricode is the mandatory procedural framework governing the inception, planning, processing and control of individual health building schemes. The aim is to promote a consistent and streamlined approach to capital development that achieves best use of resources through the selection and construction of relevant and cost-effective schemes that open on time and within budget. It identifies the main activities and provides a framework for delegation with effective management and the proper accounting for expenditure and performance. (See 'Capricode Health Building Procedures' issued with HN(86)32 in October 1986 – in Wales, WHC(86)62.)

Cost allowances

1.16 The NHS is notified separately of the Departmental Cost Allowances for this Note.

Equipment

1.17 Equipment is categorised into four groups:

- **Group 1**
  items (including engineering terminal outlets) supplied and fixed within the terms of the building contract;
- **Group 2**
  items which have space and/or building construction and/or engineering service requirements and are fixed within the terms of the building contract but supplied under arrangements separate from the building contract;
- **Group 3**
  as Group 2 but supplied and fixed (or placed in position) under arrangements separate from the building contract;
- **Group 4**
  items supplied under arrangements separate from the building contract, possibly with storage implications but otherwise having no effect on space or engineering service requirements.

1.18 Group 1 items are provided for in the cost allowances associated with this Note. The Equipment Cost Allowance Guide (ECAG) specifies a sum of money for Groups 2 and 3. Radiological equipment is normally Group 3.

2.0 General service considerations

Introduction

2.1 A consultant radiologist, an experienced radiographer, and a radiological engineer experienced in the provision and installation of radiological equipment, should be involved with the project team from the beginning and throughout the continuing stages of the project. Individual specialists such as the Radiation Protection Adviser (RPA), radiology nurse, etc will also be needed to advise on specific aspects.

2.2 Due to the continuing modification of imaging equipment and the development of new equipment, it is advisable to leave the selection of equipment for diagnostic rooms as late as possible. Consequently, it is not feasible at the design stage, or indeed early building stage, to select the particular equipment to be installed. It is therefore recommended that provision should be included in the contract for the cost of pre-installation work and that the fitting-out of the rooms in preparation for the installation of equipment should be left as late as is practicable. The radiological engineer is usually responsible for providing information on the installation of equipment and will work closely with the pre-installation planning department of the equipment manufacturers.

Nursing facilities

2.3 Nursing assistance is now an integral part of an increasing number of radiological procedures. This has resulted in a significant increase in the ancillary space and facilities required. There will be considerable variation between hospitals, and preliminary assessment is necessary to determine needs. Nursing advice should be obtained.

Size of the department

2.4 In planning a radiology department its size should be expressed in terms of the number of diagnostic rooms, irrespective of their use. In order to avoid initial over-provision the department should be designed and located to permit phased expansion, care being taken to ensure that each phase is viable within itself and that the department will function as a complete entity regardless of its size.

2.5 It should be noted that a large radiology department is likely to be more efficient than several small ones because staff and equipment can be more effectively employed. Departments should as far as possible be centralised, which may allow the number of diagnostic rooms to be reduced. Satellite rooms are generally not cost-effective; only exceptionally should fixed equipment be provided outside the radiology department.

2.6 The output of specific diagnostic rooms will vary considerably depending on such factors as the type of equipment installed and scope of examinations undertaken. For individual schemes it is important for the project teams to make full use of their professional advisers to obtain statistical and other relevant material. Recognition must be given to particular local needs and related trends, together with geographical, demographic and organisational factors which might be expected to change.

2.7 A method describing how the number of imaging rooms likely to be required can be calculated is given in Appendix 6 together with a worked example.

Location of the department

2.8 Radiological services must be available both in and out of normal working hours. The radiology department should be sited immediately adjacent to the accident and emergency department, which would normally be located at ground floor level. The department should be easily accessible from the out-patient accommodation, the in-patient accommodation and main entrance (see Figure 1). Only in exceptional circumstances should satellite imaging rooms be provided in the accident and emergency department or elsewhere.

2.9 The following aspects of siting merit particular attention:

a. The relationship between the radiology department and the accident and emergency department is important since emergency medical care for severely injured patients may continue in the imaging rooms. Thus the clinical areas of the two departments should be contiguous.

b. The planning of the radiology department should reflect the operational policies for dealing with major incidents determined in accordance with HC(90)25. These policies may identify the possible use of adjoining departments or other spaces when the accident and emergency department is required to deal with an influx of patients following a major incident.

c. The relationship between the radiology department and the plaster facilities/fracture clinic is significant, as relatively large numbers of patients, many of whom will have difficulty in walking, are referred from one to the other.

d. The need for close proximity of the antenatal clinic to the radiology department will depend upon where obstetric ultrasound facilities are provided.

e. It is also of particular importance that the relative locations of the radiology departments and wards be considered with regard to movement of in-patients outside normal working hours.

Internal departmental relationships

2.10 The radiology department should be designed so that it is possible to undertake diagnostic examinations outside normal working hours without activating the whole department. Access to these facilities will be required by both the accident and emergency department and the wards at all times. Processing and clerical facilities and sub-waiting space should also be available at all times.

2.11 It is similarly important that the various activities within the department are correctly associated to ensure that it functions in as rapid and efficient a manner as possible. The necessary relationship between the diagnostic rooms and the processing/viewing areas and the connection between the sorting, reporting and dispatch areas are examples of this need (see Figure 2).

Departmental alarms and communications

2.12 The four types of communications systems which will normally operate within the radiology department are:

a. telephone: extensions from the hospital central telephone system for communication with other departments and outside the hospital will be provided in accordance with the whole hospital telephone policy;

b. departmental intercommunication systems: a hospital central telephone system served by electronic exchange equipment should meet virtually all the internal communication requirements in this department. However, due to the character of the diagnostic techniques used during ultrasound examinations and in the CT control room, it is usual to provide intercom stations, controlled from the departmental reception point. This permits "hands-free" speech contact between the receptionist and diagnostic staff in these rooms (see paragraph 5.83).

   If certain diagnostic rooms are either reserved for, or primarily associated with, acccident and emergency requirements, it may be appropriate to extend to those rooms the intercom system which is provided in the accident and emergency department (see paragraph 5.85).

c. patient/staff call system: this system enables patients to call for assistance and staff to summon help in an emergency. Provision will be needed for patient-to-staff calls from each patient area, for example changing cubicles, recovery area and WCs. Facilities will also be needed for staff-to-staff calls from the patient areas and, in addition, from all diagnostic and treatment rooms. The main termination panel should be located at the nurse base and repeated at reception and be clearly visible from the senior radiographer's desk sited in this area. A switch-through facility to the accident and emergency department or to an appropriate centrally manned point should be installed to cover emergency calls outside normal working hours (see paragraphs 5.75–5.79).

d. hospital staff location system: the staff location system employed throughout the hospital should be extended to give adequate cover to this department (see paragraph 5.80).

Miniaturisation and microfilming

2.13 Project teams will need to consider the cost implications of storage of reduced-size films within the department, compared with storing full-size films elsewhere. Current Departmental guidance on the storage of records (HC(89)20) should be borne in mind and also HBN 47 – 'Health records department'.

2.14 Films may be reduced in two ways:

a. miniaturisation: this is the reduction of full-size X-ray films to 100 mm square, which can normally be satisfactorily viewed without magnification. The miniaturisation process can readily be undertaken within the department with appropriate equipment, either immediately after the examination or selectively, subsequent to reporting;

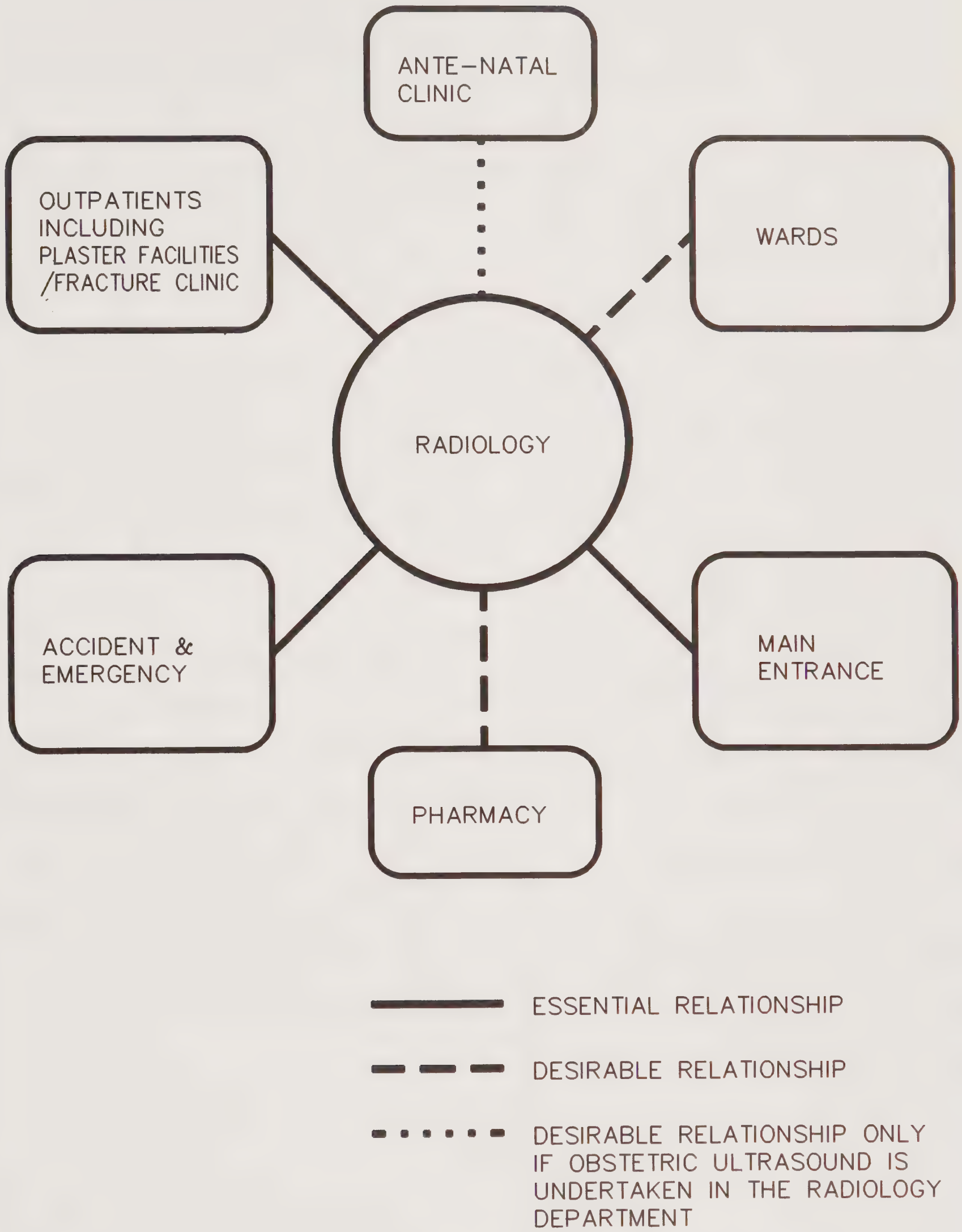
b. microfilming: this is a reduction of full-size X-ray films to a smaller format such as 35 mm, which requires magnification for viewing. It may also be convenient similarly to reduce other radiological data to enable it all to be viewed simultaneously. This process is not easily undertaken within the department and normally requires the services of a commercial organisation.

In either case the resulting films may be stored in appropriate folders in cabinets or retrieval units, and thus be retained in the smaller format within the radiology department.

Radiation protection

2.15 Authoritative advice on radiation protection and on the interpretation of relevant statutory requirements must be obtained from the Radiation Protection Adviser to the health authority, who should be consulted at the outset and

Figure 1 Locational relationships with other departments.



then as necessary throughout the project. Summaries of the statutory requirements, the management responsibilities of health authorities, and substantive advice on acceptable practice in relation to the use of ionising radiations and radioactive substances, are contained in HC(89)18. These documents, which are listed in the Bibliography, will have important consequences for the design of the radiology department, the installation of radiology equipment and the storage, preparation, use and disposal of radioisotopes; project teams should be aware of them.

2.16 In order to ensure that imaging rooms incorporate appropriate radiation shielding for all persons outside the rooms, the choice of constructional materials for floors, ceilings and walls (including windows and doors) must be agreed with the Radiation Protection Adviser.

2.17 Some special procedures undertaken in diagnostic rooms may require the use of medical laser equipment. Laser beams can be harmful and advice should be sought from the Laser Protection Adviser to the health authority. Comprehensive guidance on the potential hazards and the precautions necessary is given in the DHSS publication 'Guidance on the safe use of lasers in medical practice'. Project teams should ensure that the recommended precautions appropriate to the class of laser equipment likely to be used, are incorporated.

Radiation hazard/warning signs

2.18 Illuminated warning signs, in accordance with the guidance mentioned above, must be provided at each entrance to every radiodiagnostic room. The Radiation Protection Adviser should be consulted over their siting, and examples can be seen in the Department's signposting manual, HTM 65 – 'Signs'.

Prevention of cross-infection

2.19 Some examinations (described in Appendices 3 and 4) which will be carried out in a specialised diagnostic room are extremely complex and may be likened to surgical procedures. Appropriate cleaning and disinfection procedures need to be developed and followed in accordance with the local operational policy for the prevention of cross-infection.

Environment

2.20 Good interior design can contribute to good staff morale and making patients feel at ease. The aim should be to create a pleasant and cheerful environment throughout the department within the constraints of clinical requirements. Natural ventilation and natural or borrowed light from adjacent spaces should be provided whenever the building form and clinical considerations permit.

2.21 The design should reflect the need to preserve the dignity and privacy of patients, particularly where men and women are examined in adjacent areas or share certain accommodation and circulation spaces. There should be auditory privacy where it is required by the function carried out in the space. Patients' main waiting and sub-waiting areas should be comfortable and have tasteful colour schemes.

2.22 Diagnostic rooms have complex functional requirements but they should be designed to present as orderly an appearance as possible. Attention should be given to heat generated by equipment and its effect during certain special procedures. Air cooling may be required in order to avoid working conditions becoming uncomfortable for staff and patients (see paragraph 3.23).

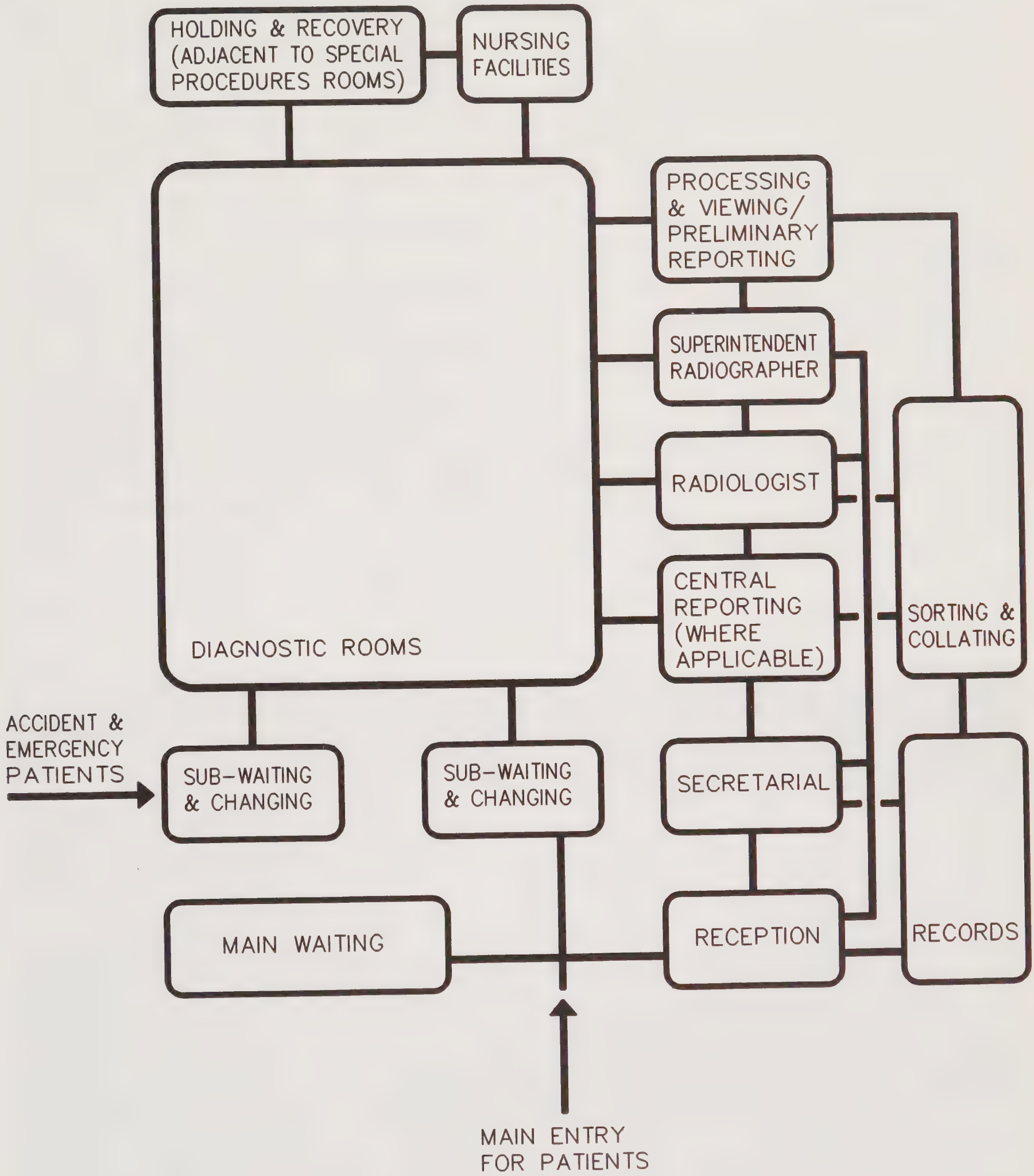
Children's needs

2.23 The special needs of children should be considered by the project teams and appropriate facilities incorporated.

Internal spaces

2.24 Internal rooms may contribute to economy in planning but the resultant additional artificial lighting and ventilation which may be necessary will add to both capital and running costs. Such rooms are not conducive to good working conditions and should be limited to supporting service rooms or those spaces which are either infrequently occupied or demand a controlled environment. Rooms which are likely to be occupied for any length of time by staff or patients should have windows.

Figure 2 Main relationships within the department. (The flow lines indicate the main relationships but do not signify their degree of importance.)



3.0 Functional requirements

Introduction

3.1 This chapter enlarges upon the objectives, functional requirements and design implications of each of the main elements in the accommodation described. Activities, equipment, environmental conditions, and finishes of walls, floors and ceilings are detailed in the Activity Data Sheets listed in Chapter 7.

Patient flow

3.2 A common sequence of patient movement (see Figure 3) through a radiology department is:

a. arrival at reception (escorts would report some arrivals) for documentation;

b. the clerical or auxiliary staff direct the patient to the main waiting area or to a diagnostic room sub-waiting area;

c. preparation of patient for procedure if necessary, for example undressing in a changing cubicle;

d. diagnostic examination or other procedure;

e. remaining in the diagnostic room or returning to the sub-waiting area or a cubicle to wait until any images have been processed, checked and reported, as appropriate;

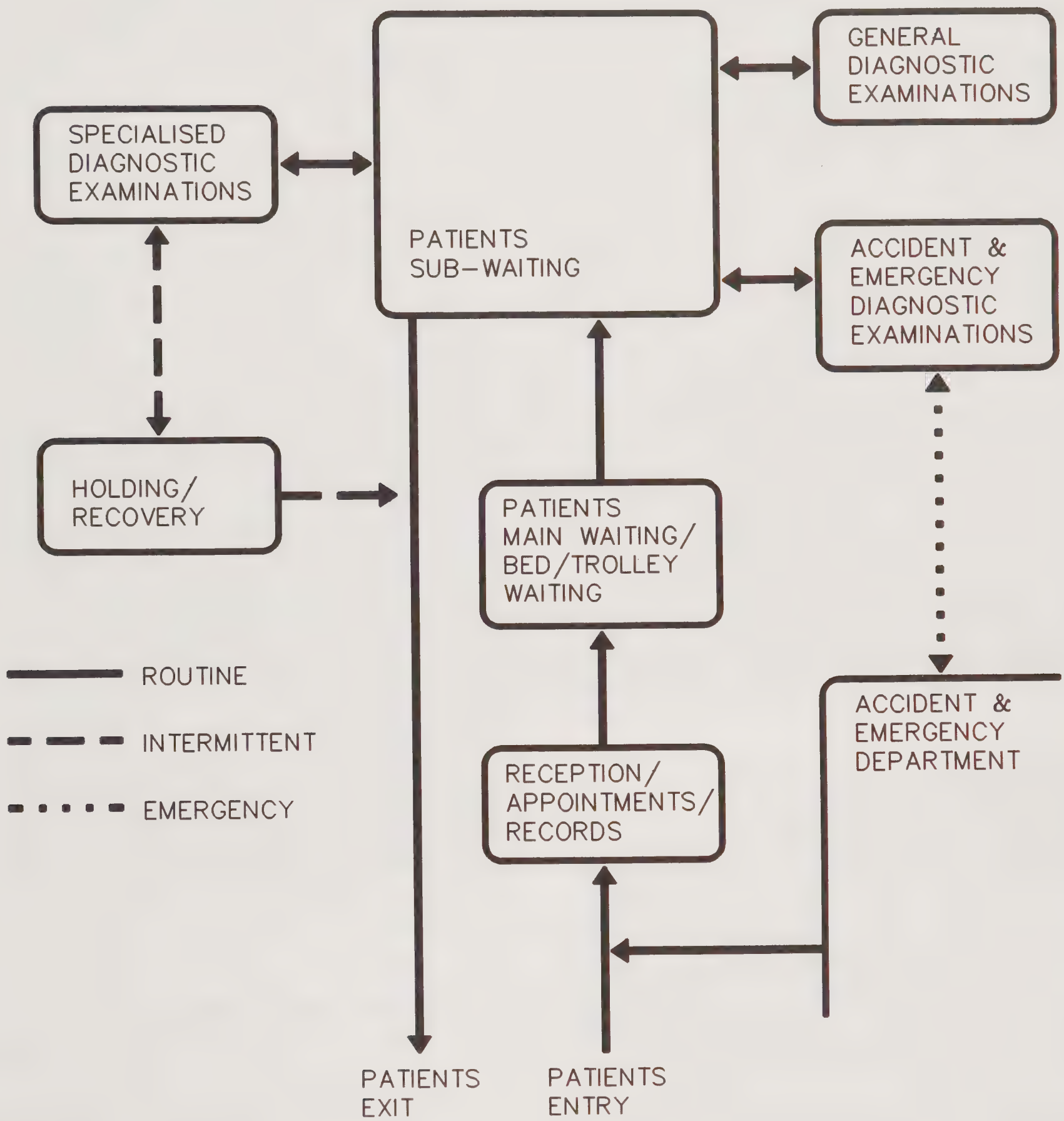
f. patient leaves the department (after recovery, if appropriate).

Reception/appointments area

3.3 The reception/appointments area is the focal point of the department, and should be designed to serve the whole department. Patients should report their arrival here as it is desirable for patients' records to be centrally managed. There should be a counter for registration and appointment procedures and a separate section with auditory privacy to allow for confidential discussions. Counter design should assume multiple use of video display terminals (VDTs) and take account of wheelchair users (see HBN 40, Vol 4 – 'Designing for Disabled People'). If geographical considerations require provision for a subsidiary reception point, computer linking is essential. A workstation for a senior radiographer should also be provided in this area for workflow pattern control, technical enquiries and general supervision.

A single reception area to serve the whole department.

Figure 3 Patient flow – sequence of activities (assuming direct access from the accident & emergency department).



This diagram illustrates activities and is not intended to represent spaces.

A patients' main waiting space, with natural lighting and ventilation.

Patients' main waiting area

3.4 The main waiting space for patients and their companions should be controlled by and overseen from the reception area, whilst being easily accessible from the entrance to the department. It should have a comfortable and relaxing environment with domestic-type finishes and furnishings. Food and drink dispensers are not appropriate for this area. Natural light and ventilation are desirable.

Bed/trolley/wheelchair waiting area

3.5 An area, separate from the other waiting areas, should be provided for patients on beds or trolleys to wait in before diagnostic or other procedures. It may also be desirable for patients in wheelchairs to wait here rather than in the main waiting area. The space allowed should reflect which option is chosen. In this area circulation space will be required for nurses or others attending the patient and for additional equipment which may be on trolleys. This area may be a recess off the relevant circulation space and should be observable from the reception point. Curtaining should be provided for privacy when required.

Porters' base

3.6 A space for porters, also capable of being overseen from reception, should be provided near the entrance to the department.

Master index/report index/diagnostic index

3.7 Data storage should be adjacent to or form part of the reception/appointments area (see paragraph 3.3). Computerised radiology management systems are now available for data recording and storage and are in common use. Direct data links with wards and other departments will make it easier for more rapid transfer of information.

Patients' sub-waiting area

3.8 Sub-waiting spaces should be provided convenient to the diagnostic rooms for patients awaiting examinations or subsequent film checks. Each space should normally serve

at least two diagnostic rooms. Where possible, sub-waiting spaces should have natural light and ventilation and be designed to afford reasonable privacy for patients.

3.9 The space associated with accident and emergency patients should allow for a greater proportion of patients in wheelchairs. It should also be borne in mind that this space will need to be available for use outside normal working hours and may need to accommodate patients on trolleys during those times.

3.10 Dedicated waiting facilities must be provided for patients who have received radioactive substances (see paragraph 3.31c).

A patients' sub-waiting space conveniently situated to the diagnostic rooms. (See HTM 65 'Signs' for current radiation hazard/warning signs.)

Changing cubicles

3.11 Cubicles should be planned in groups and be associated with sub-waiting areas. They should provide facilities for patients to dress and undress in privacy and for the secure storage of clothing during their examination. Separate administrative arrangements should be made for the safety of valuables. Cubicles should have some means of identification, for example numbering or colour-coding both inside and out. Three changing cubicles will generally be required to serve each diagnostic room. One of the cubicles in each group should be suitable for use by patients who require assistance.

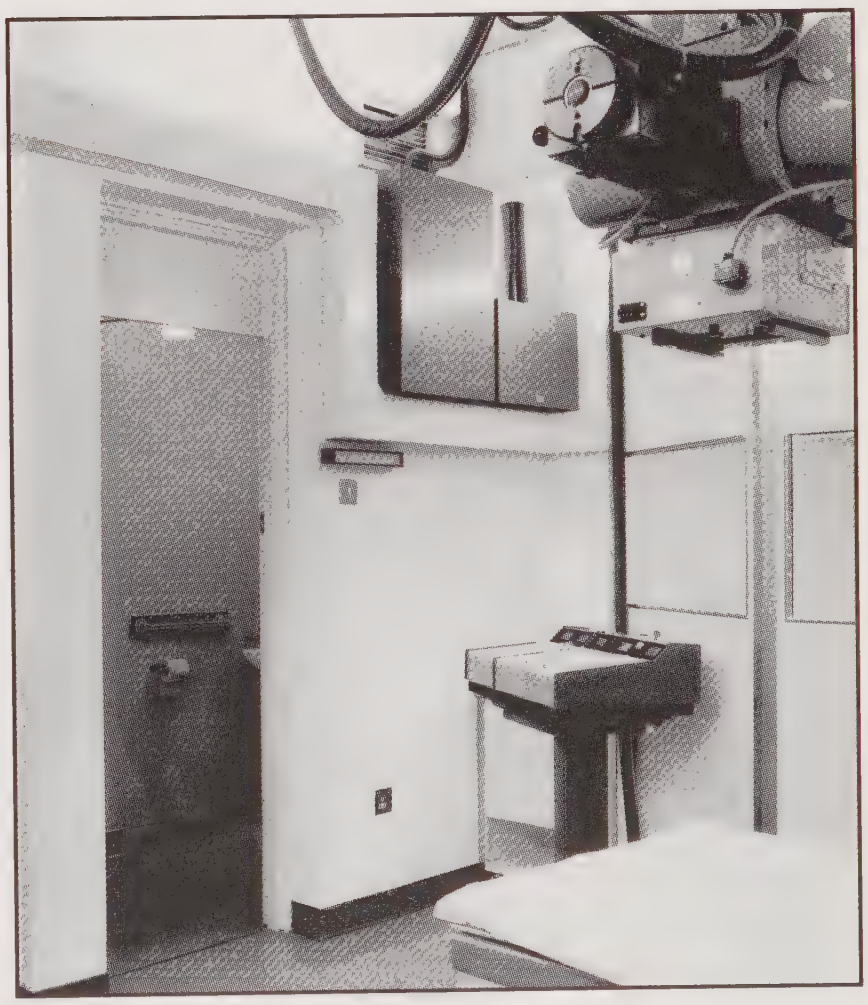
3.12 Changing cubicles can be used more intensively if patients carry their clothes with them in bags or baskets and thus the overall numbers of cubicles can be reduced. This system needs an increased sub-waiting area and may also involve a supervised secure storage location if the bags or baskets are not to be taken into the diagnostic rooms.

3.13 Alternatively, cubicles may be of a pass-through type with a door at either end, one of which provides controlled access to a diagnostic room and must therefore be radiation-protected. These doors are costly to provide, and restrict the use of valuable wall space in the diagnostic room. An advantage of such cubicles is that they enable patients to wait in them, and not in the sub-waiting area, in a semi-undressed state. However, some patients find these cubicles claustrophobic and they are less flexible in use, being dedicated to a single room.

Patients' WCs

3.14 The number of patients' WCs required will depend on the size of the department. They should be located convenient to the main and sub-waiting areas. At least one such WC should be for wheelchair users.

3.15 Sufficient assisted WCs with bidets should be provided for patients' use on completion of barium enema examinations. In view of the large amount of barium, these WCs should have suitable drainage (see paragraph 5.93). These WCs should be immediately adjacent to, but should not have direct access from, the fluoroscopy rooms. For patient privacy, it should not be possible to observe these WCs from the main circulation space and sub-waiting area.



A barium enema WC should not, as shown here, have direct access from a fluoroscopy room, as this impedes the use of both rooms.

A dedicated WC is required for patients who have had radioisotopes administered. Drainage should be arranged accordingly (see paragraph 5.97).

3.16 There should also be a WC adjacent to any room used for urographic examinations (Appendix 4) or ultrasound investigations.

Diagnostic rooms

3.17 Detailed user requirements can be found in the Activity Data Sheets and critical dimensions are given in Appendix 1.

3.18 Decisions on individual room functions and layouts should be taken by the project team in consultation with a radiologist and superintendent radiographer from the department concerned. In broad terms, diagnostic rooms fall into two categories: general purpose rooms; and specialised rooms, which may be dedicated to a single type of procedure, or which may be used for a spectrum of special procedures. Specialised rooms will need to be larger than a general purpose room when used for special procedures such as angiography, but facilities for others, such as mammography or dental work, are less demanding on space. Wherever possible, all these rooms should have natural lighting but they will require mechanical ventilation; some specialised rooms may also need the ventilation air to be cooled. Clinical handwashing should be provided in all diagnostic rooms.

Location

3.19 In selecting diagnostic room locations, care should be taken to relate the specific room activity to its position within the department. To minimise patient and staff traffic, the diagnostic rooms with a high patient throughput should be situated near to reception, and those for more protracted procedures furthest away.

General purpose and specialised diagnostic rooms

3.20 The procedures in these rooms will usually be of short duration and will require only basic equipment. These rooms need dim-out facilities and contain heat emitting equipment. They should therefore be mechanically ventilated to provide a suitable environment for patients and staff. For recommended conditions see the appropriate Activity Data Sheets.

3.21 Workflow sequence is as follows:

a. the radiographer reads the request and reviews previous reports and films (if any) on a viewer;

b. the patient is brought into the imaging room from a cubicle or waiting area;

c. the patient is positioned on the imaging equipment and the examination carried out;

d. the films are then marked with the patient's details;

e. the patient waits in a diagnostic room or returns to sub-waiting areas while the films are being processed;

f. the radiographer goes with documents and previous films to collect the newly-processed films and checks them in an associated viewing area;

g. if the films are satisfactory they are sent for reporting or direct to the clinician. If, for any reason, additional projections or views are required, the examination is repeated. Consultation with a senior radiographer or radiologist may be required.

Specialised diagnostic rooms

3.22 Workflow in these rooms will follow a similar basic sequence but will vary according to the type of examination being undertaken, and on whether or not a radiologist is directly involved. The examination times will be prolonged due to the greater complexity of the procedures used. Some of these examinations are described in Appendices 3 and 4.

3.23 Some kinds of interventional radiology require staff to wear heavy protective garments for extended periods of time. Under certain circumstances aseptic techniques may need to be adopted. These, and other procedures such as ultrasound, are usually carried out in low-level illumination. Rooms used for these procedures may need to be cooled.

A general purpose diagnostic room with natural lighting and a good relationship between the main door and the X-ray table. It should also be noted how the pass-through changing cubicles restrict the use of valuable wall space in a room of insufficient width.

In addition, depending on the function, they may require other engineering services which are equipment-specific.

3.24 Scrub-up facilities and space for gowning may be required adjacent to some specialised diagnostic rooms, depending on the nature of the procedures undertaken.

Diagnostic rooms – other common imaging modalities

Ultrasound

3.25 Ultrasound scanning is widely carried out for general diagnosis and also for the control of interventional procedures. Obstetric examinations are usually carried out in antenatal or obstetric out-patient clinics, but may be carried out in the radiology department, depending on local policy. Similarly, cardiological examinations may be performed in the cardiac department. Ultrasound examination rooms will require, in addition to the examination area, a workstation for reporting and administration tasks, and space for a multi-format and/or video camera. These rooms may be smaller than other diagnostic rooms and will not require radiation protection measures, if used solely for ultrasound.

Computed tomography

3.26 Computed tomography (CT) scanning is a common mode of diagnosis in radiology departments for whole- and part-body investigations. CT should be regarded as an integral part of the radiology department when considering service and planning issues. Radiation protection measures are similar to those required for other radiology rooms. Accessibility from the accident and emergency department is important as CT is used in the early diagnosis of head and some multiple injuries.

3.27 The CT scanner requires space for its associated computing and electrical power equipment. Depending on the CT manufacturer's requirements, this will be accommodated in either the CT diagnostic room, a separate en-suite equipment room, or the CT control room. Temperature control, including air cooling, will be required to deal with the heat dissipation from the computer equipment and to ensure that this operates within the environmental limits specified by the CT manufacturer.

3.28 Supporting the CT room, in addition to changing, sub-waiting and WC facilities, are:

a. a control room with good visual contact from the operating console to the CT gantry. Auditory privacy

A control room with good visual contact from the operating console to the CT gantry through radiation-proof glazing.

of the control room is necessary. Speech communication between operator and patient is usually achieved by a switchable intercom;

b. an office for reporting and administration, which may also accommodate the diagnostic console.

3.29 A data manipulation console and laser printing equipment is usually associated with CT scanning. This may also serve other digital imaging modalities such as ultrasound and nuclear medicine. If provided, this equipment should preferably be accommodated in a room en-suite to the control room. Appropriate additional engineering services for electrical power, water supplies and drainage will be required in accordance with the equipment manufacturer's requirements.

3.30 If insufficient shared storage is available, the CT suite may require a storeroom for such items as computer sundries, ancillary equipment or stationery.

Nuclear medicine imaging

3.31 Radiology departments will normally include a nuclear medicine imaging facility although in some instances it may be managed by the medical physics department or a physician with special interest. In addition to an examination room incorporating a gamma camera there will need to be:

a. a patient preparation room with storage area for the radioisotopes;

b. a designated WC and shower for use by patients who have received radioisotope injections. The effluent from these will be slightly radioactive and the drainage system must be designated accordingly (see paragraph 5.97);

c. a dedicated waiting area for post-injection use. In designing this waiting area it should be recognised that some patients have to spend long periods here while a suitable time interval elapses. A comfortable domestic environment is therefore important including television and reading facilities;

d. a dedicated disposal hold for the secure holding of radioisotope waste, such as partially-used doses or contaminated materials.

3.32 The need for an office, reception, utility, storage and preliminary waiting accommodation will depend on the departmental layout and may be incorporated in the general provision. Radiopharmaceuticals are commonly provided by a hospital pharmacy, as indicated in HBN 29 – 'Accommodation for pharmaceutical services'.

3.33 The expensive crystal detector within a gamma camera can be damaged if there is a too rapid rise or fall of the temperature within the examination room containing the equipment. Therefore the control of the heating in this room needs to be arranged accordingly (see paragraph 5.25).

3.34 The Radiological Protection Adviser must be consulted about the layout and provision of a nuclear medicine imaging facility. Appropriate precautions are necessary for the receipt, storage, handling and administration of radiopharmaceuticals. Post-injected patients can also be a potential hazard to each other and should be kept at least 1.5 m apart. Escorts and staff should also take care to maintain an appropriate distance. Children and pregnant women should be excluded from this facility.

Ceilings and ceiling-mounted equipment

3.35 The majority of diagnostic rooms contain ceiling-mounted equipment such as X-ray tubes or image intensifiers or both. To support the overhead equipment and its services, it is recommended that a load-bearing modular steel grid should be hung from the structural floor slab of the storey above. This will provide built-in flexibility for the choice and location of equipment, both initially and in the subsequent life of the building. The grid should be integrated with the suspended ceiling, concealing primary services distribution, and designed so that the tracks can be mounted wherever required at the level of the suspended ceiling. The latter should comprise demountable modular tiles with interchangeable recessed modular lighting fittings which are capable of being placed in any desired position so that they are not obstructed by the equipment.

3.36 The ceiling-mounted equipment which is currently available can impose a moving load of up to 1500 kg and a possible horizontal force of up to 1600 kg. The maximum deflection of the supporting tracks when loaded must not exceed 1.5 mm, irrespective of the location of the carriage. Project teams are advised to consult the suppliers or manufacturers about the weight factors of all equipment as these can vary considerably.

3.37 In diagnostic rooms there must be a clear minimum height of 3.1m (over the whole room) between the finished floor level and the underside of the support grid for the direct suspension of radiological equipment to enable certain types to be operated over their full working range.

3.38 It will be necessary to consider the location of lighting fittings when positioning equipment. There are three key requirements:

a. patients under investigation who will be lying on X-ray tables should not have to look directly up into bright lights;

b. the movement of ceiling-mounted equipment should not unduly obstruct the light produced;

c. variable levels of illumination should be possible to enable certain tasks to be performed:

   (i) a low level of lighting ("dimlights") is required for a radiographer to clearly see the light beam

diaphragm when positioning a patient and aligning the X-ray beam, and for a radiologist to study radiographs on a viewing box or images on a monitor;

(ii) general lighting ("brightlights") is required for certain investigations and for maintenance and cleaning;

(iii) for critical examination, a mobile examination lamp, which can be shared between several diagnostic rooms, may be used to supplement the general lighting.

3.39 The construction of modular suspended ceilings enables modular ceiling panels and recessed lighting fittings to be interchangeable. When a suspended ceiling cannot be provided it will be preferable to install lighting fittings at or near the junctions of walls and ceilings. If lighting fittings are at lower levels on walls, or near to eye level, they can cause an uncomfortable glare.

Walls

3.40 There are two types of wall in diagnostic rooms, one of solid construction and the other hollow-core partitioning. The latter provides flexibility in the use of rooms and enables services to be installed within them. Both types of wall must have radiation protection to the standards required. Ducts, pipes, and holes through walls should be radiation-protected by the use of dog-legs or other devices. Project teams should consult the radiation protection adviser. Walls should have a load-bearing capacity for equipment. This requirement may involve a side thrust of up to 200 kg and point loads of up to 100 kg. Walls should be flush and without structural protrusions.

Floors

3.41 It is essential that great care is taken in the design of the floor. Equipment will normally be replaced a number of times during the lifespan of a radiology department and initial planning should ensure that this can be done with the minimum disruption to the room concerned. The floor in each room should be capable of supporting a total load of up to 5000 kg, although no single item of equipment is likely to weigh more than 2500 kg. The radiological engineer should be consulted on the likely weights of such equipment. The floor should permit easy installation of trunking, 100 mm in depth, with a minimum cross-sectional area of 150 cm^2 required for cables to diagnostic equipment and other apparatus. Alternative methods which may be employed to increase flexibility when exchanging equipment and installing new cable runs are described in detail in Appendix 5.

3.42 To ensure ease of access for wheelchairs, trolleys and beds, the floor surface should be at the same level as the surrounding corridors. For hygiene and ease of maintenance the floor finish should be impervious to fluids.

Diagnostic equipment

3.43 Provision should be made in all diagnostic rooms for basic equipment. Such equipment will normally include one or more of the following individual items:

a. high voltage transformer (generator), maximum weight 750 kg;

b. control console, maximum weight 400 kg;

c. equipment control racks, maximum weight 300 kg;

d. X-ray tube support:

   (i) floor to ceiling (usually known as 'tube column'), maximum weight 300 kg;

   (ii) ceiling-mounted X-ray tube support, maximum weight 400 kg;

e. X-ray tube, maximum weight 100 kg;

f. other examination equipment:

   (i) X-ray table and/or examination equipment, maximum weight 2500 kg;

   (ii) chest stand (or equipment), maximum weight 200 kg;

g. racks for protective clothing, aprons and gloves, maximum weight 50 kg;

Appendix 7 gives details of the above equipment.

3.44 Dependent on room usage, provision may be required for the following additional equipment:

a. film viewing box;

b. mobile or ceiling-mounted monitors for diagnostic images;

c. ceiling-suspended image intensifier, maximum weight 450 kg;

d. VDT or computer workstation for the departmental data system.

Control cubicle

3.45 The control console should be placed behind a radiation-proof screen. This area is known as a control cubicle. The cubicle must provide radiation protection for the operator at the control console and for other staff who are present during a radiological examination. It may also provide protection for access into an adjoining processing area. If the screen is located in front of the access to the processing facilities and fully protects the opening, a radiation-protected door need not be provided. There may need to be a lightweight door for auditory and/or visual privacy. The screen should have a lower section of solid construction to a maximum height of 1.1 m with an upper section of radiation-proof transparent material which allows an unimpeded view of the patient at all times. The total height of the screen should be not less than 2 m from the

finished floor level. The degree of radiation protection required can vary with circumstances. It is therefore essential to seek the advice of the Radiological Protection Adviser on this aspect.

A radiation-proof screen to a control cubicle, providing the radiographer with an uninterrupted view of the patient.

Medical gases

3.46 Piped oxygen and vacuum should be provided in each diagnostic room and recovery area. In addition, nitrous oxide may be required in each special procedures room. Where nitrous oxide is used, a gas scavenging system will be required. As it is not possible to ensure that diagnostic equipment and associated apparatus is spark-proof, only non-flammable anaesthetic gases and materials must be used. Antistatic floors will not be required.

Reporting and administration

Viewing, checking and preliminary reporting area

3.47 Films and/or images will be examined by the radiographer immediately they are processed. This will determine whether they are of satisfactory technical quality and, with the help of senior radiographers or radiologists where necessary, whether the examination is complete and the patient may leave the department or if a further film is required. Film viewers for checking (and possibly for preliminary reporting) should be provided near the "output end" of automatic processing units. It is anticipated that one VDT will be provided per radiology room in this area. Project teams may increase this provision dependent on local policy.

3.48 If the department is to be wholly electronic or "filmless", the primary viewing for technical quality is likely to be on a monitor in the diagnostic room, probably situated behind the protective lead screen. Secondary viewing will be in a viewing/checking/reporting area where banks of monitors (linked via a network to the central reporting area and the consultant offices) will be available for image comparison. There will be need for privacy for consultation with senior radiographers and/or radiologists. For many years conventional viewers will still be needed for some of the comparisons.

3.49 The proper location and function of the viewing/checking/preliminary reporting areas in relation to the diagnostic rooms and processing areas is paramount to the speed and efficiency of the department. They should be adjacent to, or part of, each processing area and should contain worktops and viewing facilities. Space will be required for the radiographers to undertake the pre-examination assessment of the patients' data, including previous films, and subsequently to check the processed films and to carry out preliminary sorting. Immediate or preliminary film reporting by a radiologist may be required for patients from the accident and emergency department, the wards and during out-patient sessions (see also paragraph 3.51b). Depending on local arrangements, this can be undertaken either here or in other reporting areas

A viewing, checking and preliminary reporting area.

(see paragraphs 3.57 and 3.95). Facilities will also be required for film reject analysis.

3.50 Separate viewing/checking/reporting areas should be provided for diagnostic rooms which have special functions. For example, one area may be allocated to the section of the department designated to serve the accident and emergency department. Some procedures, for example barium meals, enemas and angiography etc, produce a large number of films. An area, or designated section of a large area, should be available for their simultaneous viewing and checking.

3.51 One of the following courses of action is likely to be followed after film checking (see Figure 4):

a. routine procedures; current and previous films (if any) and documentation are taken to the sorting area for collation and reported on in batches;

b. immediate reporting and dispatch; in cases of clinical urgency, films may need to be reported on immediately by a radiologist. In such circumstances it is desirable to have previous films and reports available for comparison. If this is not possible care should be taken to ensure that such 'preliminary' reports are reviewed for confirmation of findings when the previous films and documents are present;

c. dispatch of unreported films; if immediate reporting is not available, and the clinician wishes to see the films before the patient leaves the hospital or before deciding on treatment, the unreported films are dispatched to that clinician, usually in a suitably distinctive "unreported films" envelope. Where possible, previous films will be included for comparison. The patient's original envelope and documentation will be taken to the sorting area to await the return of the unreported films.

Sorting and collating area

3.52 Project teams should pay particular attention to the design of the area used for the sorting and collating of X-ray films. If this area is not well designed it can have serious consequences for the throughput of the radiology department, and hence the patient throughput of the hospital as a whole.

3.53 Sorting and collation should be carried out in an area adjacent to reception/data storage. In order to achieve an easy flow of work, an open-planned area comprising sorting and collating, dispatch and return and current film storage has many advantages. The accommodation should be near to the radiologists' offices and, in larger departments, to the central reporting room. Ample worktop space with viewing facilities and storage racks will be required for the various activities undertaken in this area. At least one VDT will be required at each workstation for data access when locating films.

3.54 The following activities take place:

a. ensuring that when current and previous X-ray films (if any) are received from the viewing/checking areas, the necessary documentation is attached before being passed on for reporting;

b. collation and temporary holding of films and documentation in cases where previous records were not initially available;

c. sorting unreported films on return from the clinician or ward and their collation with relevant previous films and documents ready for reporting;

d. retrospective collation of current and previous films and documents that were the subject of a "preliminary" report to enable the initial findings to be confirmed;

e. arrangements to ensure that the absence limit (usually one to three days) for unreported films is not exceeded;

f. sorting films for reporting into priorities or categories, for example in-patient, out-patient, accident or those for reporting on by a specific radiologist;

g. holding films for viewing by visiting clinicians.

Provision may also need to be made to include the films of patients who have been examined at satellite hospitals.

Film dispatch and return

3.55 This area is used both for the dispatch and return of films and reports and for queries concerning their whereabouts. Ample worktop space and storage racks will be required for the preparation of films and reports for dispatch. Worktop space will also be required for the sorting of returned films in preparation for filing. The films may:

a. accompany the report to the referring clinician to be subsequently returned for filing in the department;

b. be retained in the ward or department during the patient's course of treatment and be returned for filing when the patient is discharged;

c. be sent directly for filing, for example general practitioner referrals;

d. be taken out of file for

   (i) admissions (planned or emergency) and sent to the ward;

   (ii) out-patient clinics;

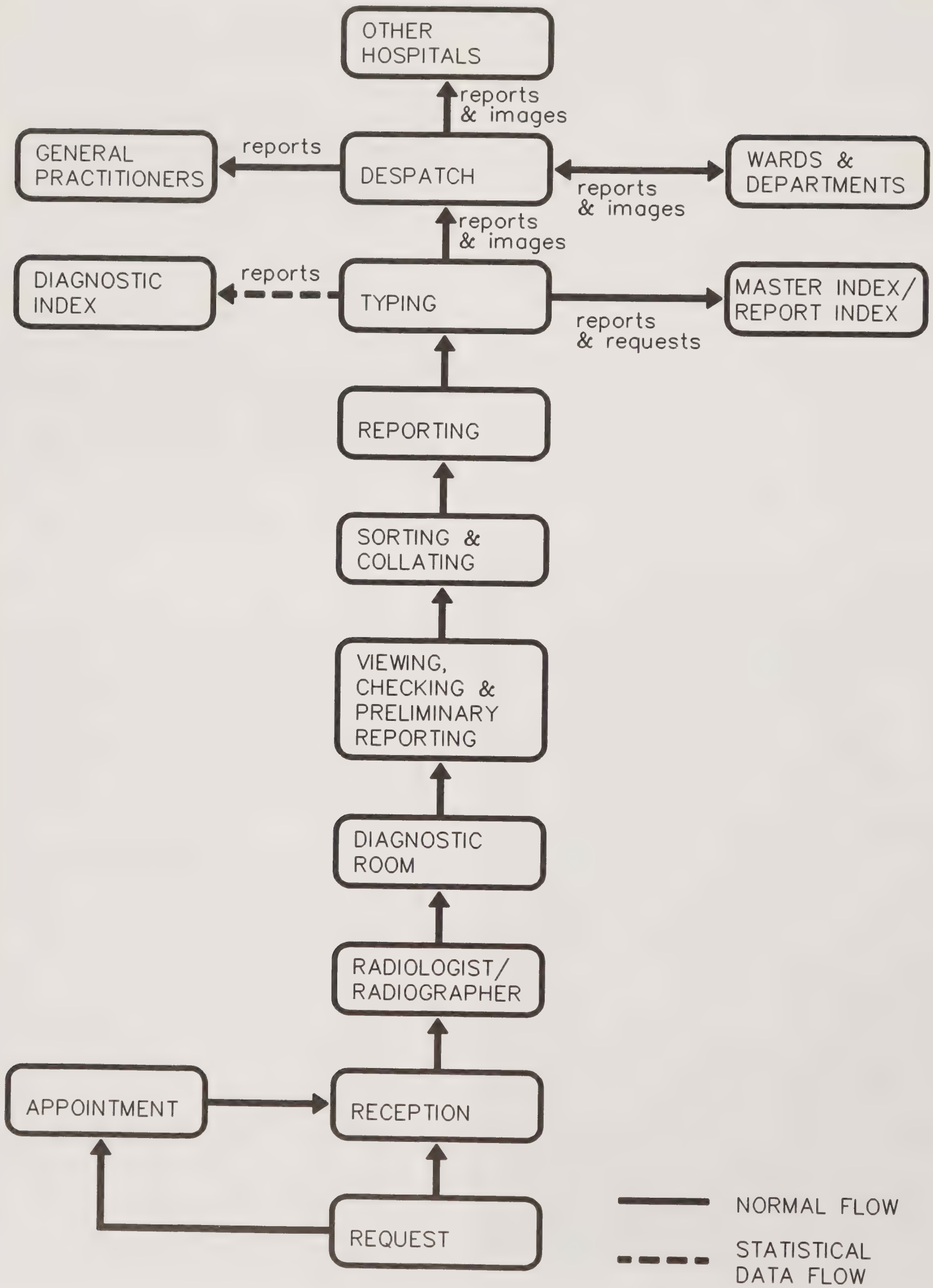
   (iii) follow-up examinations;

   (iv) other clinical needs in the hospital;

   (v) the needs of other hospitals.

Function d (ii) will be a large part of the work in this section. As electronic images replace film, much of the work of this

Figure 4 Flow of requests and reports – sequence of activities.



section will be reduced but there will be a need to convert these images, as required, into hard copy.

Film reporting and clinical conference facilities

3.56 It is essential that proper facilities are provided for the preparation of radiology reports and for clinical radiology conferences including medical audit and quality assurance reviews. Reports on films can be prepared in a number of places, such as the viewing/checking/reporting area, a radiologist's office, or in a central reporting room.

Central reporting room/clinical conference room

3.57 The majority of departments will require a central reporting facility from which the radiological staff will be able to provide a regular flow of reports. It will provide a reference point for obtaining radiological opinions. It should be near to the sorting and collating area. Informal radiological consultations frequently form part of the clinical conference associated with clinical ward rounds, and this space should be planned large enough to allow for the radiologist, other radiological staff and one or more clinical teams.

3.58 In small departments, however, it is not envisaged that a separate central reporting space will be needed and the clinical conference function can be allowed for by providing one radiologist's office with additional space.

3.59 At the date of publication of this HBN, most of the results of radiological investigations are presented for reporting as radiographs or as photographs taken directly from TV monitors or image intensifiers. Increasingly, however, diagnostic images are being produced in electronic form and are viewed primarily on TV monitors. Three types of reporting station are suitable for a central reporting room:

a. one having a minimum of two quadruple wall-mounted illuminators;

b. one having TV monitors, together with equipment to produce copies of TV images for distribution to clinicians. If patients' records are computerised the same monitors may be used as computer terminals by the provision of video mixers;

c. one equipped with an automatic multi-viewer.

The type of reporting stations selected will be dictated by project requirements.

3.60 Natural lighting will not be required but if windows are provided the room should be capable of being dimmed. Mechanical ventilation should be provided.

3.61 The radiologist, after viewing the diagnostic images, may dictate reports directly to a secretary in the central reporting room or to a dictation machine for subsequent typing. VDTs will be required for the radiologist at all stations in order to give access to past records and also for

A central reporting room with an automatic multi-viewer in use.

the secretaries at direct dictation stations. In order that these activities may take place concurrently, consideration should be given to the need for sound attenuation.

3.62 The referring clinician will need a copy of the report. This may be generated in the reporting station or, in the case of electronic transmissions, centrally in the radiology department, or remotely in a receiving station (for example a ward, department, or outside the hospital service altogether, that is, by a general practitioner). Hard copies of the reports are filed in the patient's case notes and a further copy may be placed in the film envelope. It is assumed that the departmental record is held on electronic disk storage.

Nursing facilities

3.63 Nursing facilities comprising the nurse base, patient holding and recovery area, resuscitation bay, clean utility room and dirty utility room should be provided and planned as a cluster of activity spaces in the vicinity of the specialised rooms. In departments larger than six to eight rooms, an office may be required for the nurse in charge.

Nurse base

3.64 A base is needed for the nursing staff. It should be planned as a focal point in the cluster of nursing facilities, and give direct observation of the patients in the holding and recovery area. Space is required for a desk and telephone for administration. Indicator lights for the patient and staff emergency call system and the controlled drugs cupboard should be located so that they can be seen from the desk and the circulation spaces. If there is to be a nurse's office, some of the functions of the nurse base will be transferred to it. Indicator lights for the patient and staff emergency call system and the controlled drugs cupboard should be provided in both locations.

Holding and recovery area

3.65 A holding and recovery area will be required for

a. patients' recovery from anaesthesia and/or those under observation after interventional procedures;

b. patients in bed or on a trolley who require infusions or other similar procedures prior to investigation;

c. patients in bed or on a trolley awaiting investigation and needing nurse supervision;

d. some prolonged examinations such as a barium follow-through.

Emergency resuscitation equipment may be based here (see paragraph 3.66). The amount of space required for parking beds or trolleys will depend upon the number and type of procedures carried out in the specialised rooms. It should be possible to curtain off each bed or trolley space for privacy.

Resuscitation trolley and its bay

3.66 The resuscitation trolley should be parked where it is easily available to all diagnostic rooms, waiting and main circulation areas. During normal working hours, it will be close to those rooms using intravenous contrast media and close to the holding and recovery area. Outside normal working hours the trolley will be in that part of the department which is in use. The trolley should not obstruct circulation areas but should normally be placed in a dedicated bay. The need for one or more of these trolley bays is a project decision.

Clean utility room

3.67 A clean utility room should be provided for the storage and assembly of clinical requisites used in the diagnostic rooms. These include sterile supply items, pharmacy supplies including drugs, Controlled Drugs, contrast media, and other non-sterile clinical supplies. Certain pharmaceuticals used during barium examinations may also be stored and prepared in this area (see also paragraph 3.108). Space will be required for trolleys to be "laid up" for all special examinations.

3.68 The provisions necessary for the out-of-hours access to controlled drugs will have to be considered.

Dirty utility room

3.69 A dirty utility room should be provided for the cleaning of trolleys and equipment used in clinical procedures. Depending on hospital policy, some items may be dispatched to the sterile services department (see HBN 13, in preparation).

3.70 There should be space for the temporary holding of materials for disposal and reprocessing, for example soiled linen for the laundry and any items for central cleaning.

3.71 Special consideration should be given to the provision of a slop hopper with adequate drainage to avoid clogging by barium. A bedpan washer unit or macerator, depending on hospital policy, will also be required.

Disposal hold

3.72 This room should, if possible, be accessible from within the department and also close to the hospital street. Collections, except for "sharps" containers which are held in the dirty utility room for security reasons, may then be made without portering staff needing to enter the main circulation space of the department.

3.73 Bagged refuse, used linen, and possibly sterile supply service items for reprocessing are held for collection. The disposal hold should be subdivided so that each category may be held separately, thus lessening the risk that reprocessible items are sent for incineration.

3.74 The size of the disposal hold should be determined by the ratio of the rate of accumulation of material for disposal to the frequency of collection.

Film processing

3.75 Most X-ray films can be processed without the use of a darkroom. Accordingly this Note has allowed for daylight automatic processing, and for daylight automatic processing with a darkroom facility. Imaging technology is moving towards digital storage of information. This trend is likely to reduce current dependence on the use of films, so affecting the existing systems in use. Possible future changes should be taken into account when planning projects.

Manual processing

3.76 If exceptional local circumstances require the provision of manual processing, a case should be made for the additional space required.

Daylight systems

3.77 Daylight automatic processing and film handling can be undertaken in areas of natural daylight or artificial light by the use of light-proof film feeding devices. A number of commercial daylight systems are available with differing arrangements for loading and unloading film cassettes.

Integrated daylight systems permit cassette loading, unloading and film processing to be undertaken in natural or artificial light.

These can be broadly classified into integrated and dispersed systems. In the former, the unloading and reloading of the cassettes, as well as the processing of film, are all undertaken in the one unit. With dispersed systems, the reloading of the cassettes is separated from the other processing functions.

3.78 The choice of a particular system will have a bearing on the layout of the processing areas and their juxtaposition to the imaging rooms. The total area provided should be related to, and adequate for, the number of imaging rooms in the department. The areas containing automatic loaders or dispensers should preferably be capable of having light excluded to enable some equipment malfunctions to be rectified without spoiling unprocessed films. In such situations safe-lighting should be provided. In all cases a sink suitable for cleaning the processor racks must be sited conveniently.

3.79 Each department should be equipped with automatic processors at a ratio of one to every two imaging rooms. If an automatic processor is to serve one item of radiology equipment only, it should not be included in this calculation. All departments should have at least two automatic processors, one for normal use and a smaller one of lower capacity as a standby in case of breakdown. In departments with two processors or more, a separate standby processor will not normally be required. This overall level of provision may need adjustment with the advent of digitised information, transfer and storage. Allowance may have to be made for specialised processing requirements such as dental films. The design of mechanical ventilation, electrical, water and drainage services should allow for each piece of equipment to be serviced independently. Their siting must be considered in the context of local requirements and workload demands, and be arranged so as to reduce staff movement to a minimum.

3.80 For example, an area with one processor can be located between a pair of imaging rooms, or two processors may conveniently be installed in a common processing/viewing area serving a cluster of four imaging rooms. In certain situations it may even be desirable to site a processor within an imaging room. The overall policy should be such that alternative processing facilities are always available within a reasonable distance, thus ensuring that a processor breakdown does not totally affect one type of examination.

Darkroom requirements

3.81 Although the use of daylight processing is recommended, departments will still require a darkroom for some facilities, for example loading of film magazines and cine-cassettes, film copying, and possibly dental film processing. At least one processor should therefore be sited in a darkroom, but the design of the room and choice of equipment can be such that when not required as a darkroom it can function in normal light conditions as a daylight system.

3.82 The processor should be positioned so that the "feed-in" end is in the safe-lit area (see Appendix 3) and the "output" end in the adjacent viewing, checking and preliminary reporting area. When the door is closed, magazines and cine-cassettes may be passed into the darkroom via a cassette hatch. There will be a need for safe-lighting (coupled to an exterior warning light), a white light, bench space for unloading and loading cassettes, and cupboards for storage.

3.83 Darkroom facilities suitable for specialised film processing or for changing high speed panchromatic films will be required for ultrasound images. In smaller departments this can usually be accommodated in the darkroom described in paragraph 3.81. In larger departments it will be necessary to provide an additional small darkroom for this purpose adjacent to the ultrasound diagnostic rooms. In some circumstances this space may also be appropriate as optional additional accommodation in a smaller department.

Film handling

3.84 The commonest way in which films are placed in position for exposure is by first loading each film into a light-tight cassette. Packs of unexposed films are taken from the unused film store to the integrated processing units or dispensing points which are located in the processing areas. Individual films are then placed into cassettes, ready for use in the adjacent imaging rooms (see Figure 5). After exposure, the films are fed into an automatic processor where they are chemically processed and dried ready for viewing. At all times before the completion of processing, films must be protected from exposure to light and from exposure to irradiation. Each film must be marked with particulars of the patient's identification. In order to minimise the chances of error, this should be done before the film leaves the care of the radiographer. Films may be marked while still in the cassette. This is usually carried out by a photographic method which is provided for in the construction of the cassette. In some systems marking is carried out in the film processing unit.

Replenishment of chemicals

3.85 Normally, automatic mixers are used which will open and mix packs of chemicals as required and give warning when further supplies are needed. These avoid the need for direct contact with the chemicals and eliminate the risk of the technicians being splashed during mixing. Such mixers can serve one or more processors within the same area. If central replenishment is considered, expert advice should be sought from the manufacturer. Consideration should also be given to the recycling of fixer solutions.

Silver recovery

3.86 A system for the recovery of silver to prevent pollution is essential. This system may serve more than one processor within the same area. The various methods available for the recovery of silver are described in Appendix 8. Local security arrangements must be made to ensure the safety of the equipment from unauthorised interference and also for the safe custody of recovered silver flake. For general advice on chemical effluent see paragraph 5.96.

Image storage

Current image storage

3.87 This Note assumes that all films of patients examined during the last two years will be stored in the radiology department in envelopes which may also contain reports.

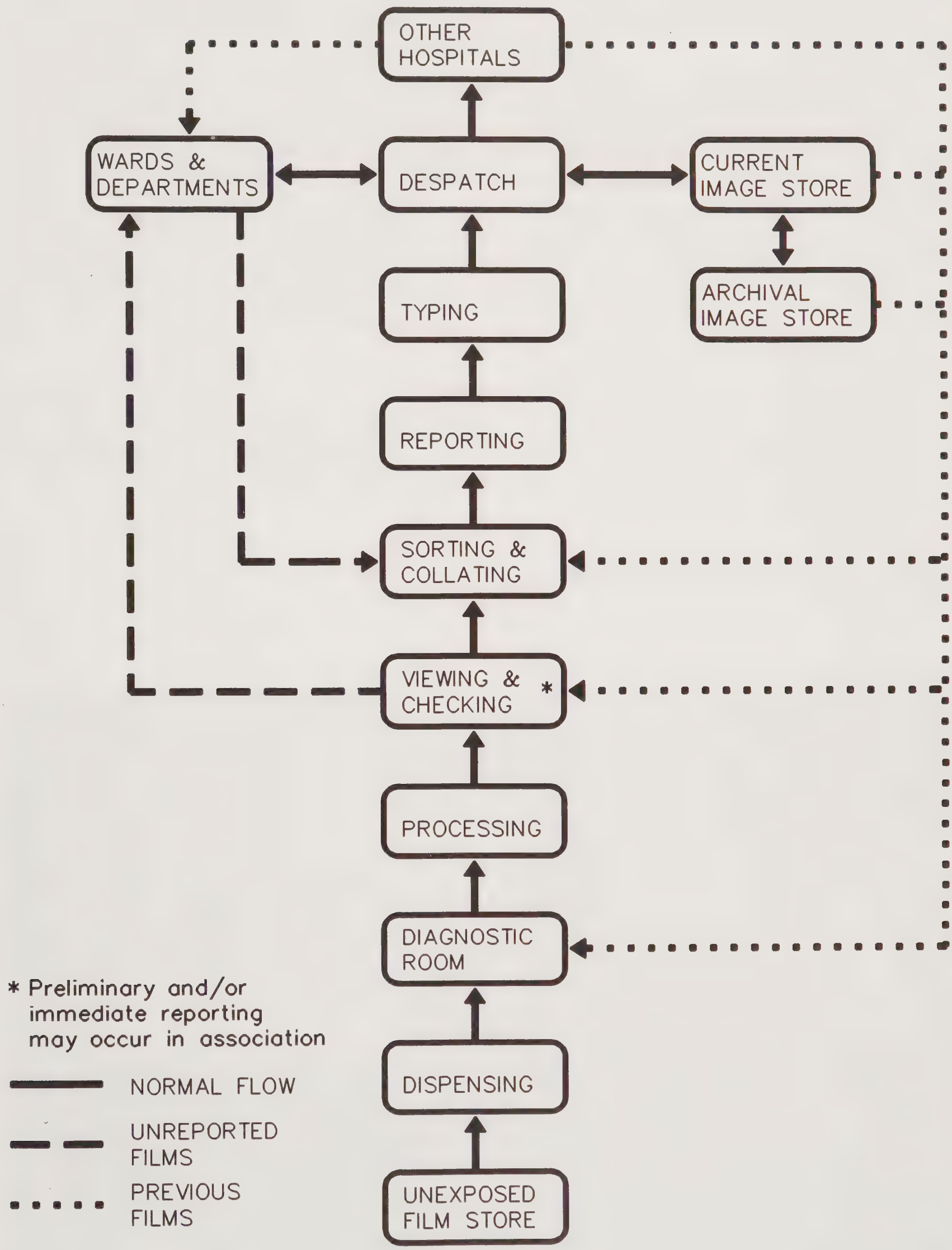
3.88 Storage for any other recording media (video or magnetic tapes, optical discs, reduced size films, etc) should also be provided. This will be of increasing significance in view of the trend towards more frequent digitalisation of images.

3.89 Current images are required for out-patient clinics, patient admissions and other medical uses within the hospital and elsewhere. Storage space for these should be adjacent to reception and patient data storage, and be directly accessible from the dispatch and return area.

3.90 Fixed racking should be provided for functional reasons and the structural design should take account of the weight of X-ray films stored in bulk. Circulation space for film trolleys will be required and space will also be needed for tables and worktops.

Current image storage requires fixed racking, film trolley and worktop.

Figure 5 Flow of films – sequence of activities.



3.91 Reference should be made to local and national statistics to determine the area required for this storage in the light of the increasing demand for radiological and other procedures, including imaging. The gradual transition to electronic image storage should also be taken into account.

Archival image storage

3.92 Decisions concerning retention beyond the two-year period should be taken by the health authority in the light of Departmental advice (circular HC(89)20 refers). If it is decided to retain images in their full-size format their location should be as convenient as resources allow, since recovery from remote locations is not economic. Mobile racking, while not suitable for current filing, may be considered for archival storage where continuous ready access is not required, thus utilising its space-saving potential. Such storage is not included in the radiology departmental cost allowance and a case will need to be made for appropriate additional funding.

3.93 Archival storage of miniaturised or microfilmed images is allowed for in the health records department (see HBN 47 – 'Health records department'; the associated NHS Estates circular EEL(91)3 gives a departmental cost allowance for this purpose).

3.94 The following should be read in conjunction with the general guidance in HBN 18 – 'Office accommodation in health buildings'.

Staff accommodation

Radiologists' offices

3.95 Radiologists' offices will be required for viewing and reporting, for consultation with colleagues and others, for audit/management and general administrative work. A VDT will be required for reporting and for the various management/administrative functions. A second VDT with appropriate work space will be required if typing is done in the radiologist's office. A printer, or easy access to one, will be needed. In addition to conventional illuminators, viewing monitors with a data manipulation facility linked to the diagnostic rooms may also be required.

3.96 There should be an office for each full-time consultant and/or whole-time equivalent consultant. There will need to be storage space for the audit and confidential records, and a limited space for books, periodicals and images of special interest.

3.97 Offices should be grouped together with easy access to the secretarial facilities and, in larger departments, to the central reporting room and seminar room (if provided). Access to the specialised diagnostic rooms is also important. Natural lighting and ventilation is desirable and the rooms should be capable of being dimmed.

A radiologist's office.

Superintendent radiographers' office

3.98 In any radiology department, there will be one or more superintendent radiographers with administrative and departmental responsibilities. Each will require office accommodation. Functional requirements will dictate the best location for these offices. They will be used for viewing of films, consultations, and discussions with colleagues and other personnel.

3.99 This office or offices should be capable of being dimmed. There will need to be a storage space for the records of administration, maintenance, radiation protection, and a limited space for books, periodicals and images of special interest. In addition to conventional illuminators, electronic image viewers may be required. The administrative work (including staff records and that of radiation protection) will require a VDT with easy access to a printer. The confidential nature of some of the printouts will make it helpful for the printer to be in the room, where it will need to be silent.

Business manager's office

3.100 An office, with standard facilities, is required (see HBN 18 – 'Office accommodation in health buildings').

Secretarial accommodation

3.101 Accommodation will be needed for the transcription and typing of radiologists' reports and for the preparation of the report and associated radiographs for distribution or filing. A VDT will be essential for each secretary who should have easy access to printers. While most secretaries/typists will share accommodation, it may be desirable for the secretary attached to the radiologist in administrative charge of the department to have a single room adjacent to his/her office. There may need to be storage space for the audit and confidential records, and a limited space for books, reference data, etc.

Staff room

3.102 A staff room will be required for general use by all staff of the department. Ideally, it should be sited near to diagnostic rooms, particularly those used outside normal working hours. It is desirable that the room should have natural lighting and ventilation and a pleasant environment. As this room will be used 24 hours a day the provision of a couch or divan would be useful so that staff working at night can rest. Facilities for beverage making and preparation of snacks are required. Sleeping accommodation for those on-call at night will normally be outside the department.

Staff changing and WCs

3.103 Project teams will need to bear in mind the staff changing requirements. Central staff changing is not normally considered appropriate for radiographers. This is due in part to the need to ensure secure and safe storage within the department of the radiation monitoring devices, individually worn on radiographers' uniforms.

3.104 Separate changing rooms should be provided for male and female radiographers. All should have full-length lockers for the storage of personal clothing, uniforms and personal items.

3.105 Staff working in offices should be able to lock personal items in desks. Coat hanging facilities will be needed in the offices (see Vol 1 of HBN 40 – 'Common activity spaces').

3.106 A WC with wash-hand basin should be closely related to the changing space for general use by staff. Additional sanitary facilities may be required.

Shower room

3.107 A shower room should be provided in the department for use by staff or patients, ideally close to the special procedures and barium enema examination rooms. This shower room is additional to the dedicated facilities provided for the sole use of patients who have received radioisotopes (see paragraph 3.31b).

Ancillary accommodation

Barium preparation area

3.108 A barium preparation area should be provided close to the diagnostic rooms used for barium examinations.

Cleaners' room

3.109 A cleaners' room to service the department should be provided.

General store

3.110 Secure storage should be provided to house small items of equipment used intermittently, for example instrument trolleys, cassette stands, contrast injector and anaesthetic equipment. Space will also be required for bulk storage of forms, stationery and small miscellaneous items. Storage for wheelchairs and patient trolleys will be a matter for local decision.

Unused film store

3.111 A film store will be required for at least one month's stock of film of all sizes in common use. It should be sited away from radiodiagnostic rooms or shielded from radiation and should be in a location with a ventilated and cool environment. The weight of the film to be stored should be taken into account in the design and positioning of shelving. Security is also important.

Chemical store

3.112 A ventilated storeroom, preferably situated near the processing areas, should be provided for storage of chemicals used in the processing of radiographs. Shelves will be required and account should be taken of the weight of the chemicals to be stored. Floor finishes should be impervious to chemical spillage.

Linen store

3.113 The provision of storage for the day-to-day working stock of linen will be required. Its size will be in accordance with the Whole Hospital policy.

Mobile X-ray equipment parking bay

3.114 Depending on local arrangements, parking space for mobile X-ray units will be required either in the department or in those parts of the hospital where the units are most used, or both. There should be facilities for charging mobile X-ray units with integral batteries. Parking bays should preferably be in areas not accessed by the general public. If in the department, the space should be convenient to the appropriate entrance.

Workshop

3.115 A workshop for servicing and repair of equipment, including mobile X-ray units, should be provided within the radiology department. Doors should be large enough to admit mobile units. Servicing and repair work involving the generation of X-rays may take place in this room. It must therefore have radiation protection, as recommended by the Radiation Protection Adviser.

Switchroom

3.116 A switchroom will be required for housing the main isolator and distribution switch-/fuse-gear for the department. The room should be dry and well ventilated and the door should be lockable and open outwards. This room should be positioned so as to minimise the cost of cabling required to serve the department.

Essential Complementary Accommodation

Seminar room

3.117 It is essential that accommodation for multidisciplinary radiological conferences should be provided within the hospital. For smaller hospitals it is anticipated that this accommodation will be shared with other users and may be sited outside the department. In larger departments and those with a high frequency of consultation (for example neuroradiology), it may be necessary to site this facility in the radiology department. This will be a matter for project decision.

Counselling room

3.118 It is important that a room is available for counselling of patients and distressed relatives. This room should be comfortable, domestically furnished and positioned appropriately either within or adjacent to the radiology department. Project teams should determine the number and location of counselling rooms depending on local operational policies.

Optional accommodation

3.119 **Note:** Not all departments will require the following accommodation, but a costing will be available.

Special procedures changing room

3.120 A changing room with shower may be required adjacent to the specialised diagnostic rooms, depending on the nature of the procedures undertaken.

Anaesthesia room/bay

3.121 Project teams will need to consider the frequency of interventional radiology requiring anaesthesia. This may in exceptional circumstances justify separate provision. If provided, it should be located adjacent to the special procedures room, and should include the same piped medical gases and vacuum, and an anaesthetic gas scavenging system, as used in the special procedures rooms.

Lavage room

3.122 A lavage room containing WC and bidet, suitable for both ambulant and trolley patients, may be required.

4.0 General design considerations

Introduction

4.1 This chapter contains guidance concerning aspects of function and design which are common to health buildings generally and which will need to be borne in mind when designing new buildings or upgrading existing premises for radiology services.

Statutory and other requirements, including Crown immunities

4.2 This Note takes account as far as possible of all statutory and other requirements in force at the time of publication, but health authorities are reminded of their responsibility for ensuring compliance with all relevant statutes, regulations, codes and standards. Advice on this is given in HC(88)60/HC(FP)(88)29 – in Wales, WHC(89)20.

4.3 With the general removal of Crown immunity from the NHS from 1 April 1991 and the setting up of NHS Trusts, building and planning law are legally enforceable on the NHS. Guidance on the removal of Crown immunity is given in HN(90)27/LASSL(90)15 – in Wales, WHC(91)4 – in respect of a wide range of legislation.

Fire precautions

4.4 It is essential that project teams familiarise themselves with the guidance contained in the Firecode suite of documents which contain the Department's policy and technical guidance on fire precautions in hospitals and other NHS premises. In particular, the need for structural fire precautions and means of escape from the whole accommodation must be taken into account at the earliest possible planning stage. The key document for these aspects in hospitals is 'Firecode: Fire precautions in new hospitals', Health Technical Memorandum (HTM) 81.

4.5 In addition, basic policy, principles and key management guidance are contained in 'Firecode: Policy and principles'. Other Firecode documents include the Health Technical Memorandum "80" series (which give technical guidance on various building, engineering and equipment issues), the Fire Practice Notes series (dealing with various specialist aspects of fire precautions) and Nucleus guidance. The suite includes 'Firecode: Directory of fire documents' which lists references to relevant legislation and relevant fire precautions guidance issued by the Department of Health and other sources, for example, the Home Office. Publications in the existing HTM "80" series are listed in the Bibliography at the end of this Note.

4.6 It is important to establish during the design stage those aspects of fire safety strategy which affect the design configuration and structure of a project. At the appropriate stages of the design process, the architect and engineer should discuss and verify their proposals with the local fire authority, and ensure that the project team and all other planning staff are fully acquainted with the fire safety strategy for the design in terms of operation (staff responsibilities, etc), equipment provision, and buildings and engineering layouts. HTMs 57, 58, 59 and 60 give detailed information on the selection of fire resisting components.

4.7 The principles of fire safety apply equally to new projects and to alterations and upgrading of existing buildings.

Security

4.8 There should be access to the radiology department at all times. It will be a matter for local decision whether or not parts of the department are locked at night for security reasons, for example the current film store.

4.9 Assaults on hospital staff and theft of NHS property are recognised problems. The project team should discuss security with the officer in charge of the local police crime prevention department, and the hospital or district security officer or adviser, at an early stage in the design of the building. Fire and safety officers should be consulted concurrently because the demands of security and fire safety may sometimes conflict. The attention of planners is drawn to circular HN(84)26 dated December 1984 – in Wales, circular WHN(85)1 – and the NHS Security Manual issued with the circular.

Damage in health buildings

4.10 When designing and equipping health buildings the likely occurrence and effects of accidental damage should be considered. Damage in health buildings has increased due to the use of heavier mechanical equipment for the movement of patients and supplies, and to some extent as a result of lightweight, often less robust, building materials. Most damage to doors, and to floor and wall surfaces, is caused by wheeled traffic. Measures to minimise damage should be taken in the form of protective corners, buffers and plates, and in proper continuation of floor surfacing, that is, strong

screeds and fully bonded floor coverings. Protective devices should be capable of being renewed as need arises. Reference should be made to the relevant British Standards, to the advice given in the Department's DS (Supply) letter DS 42/75 dated August 1975 on the buffering of moveable equipment, and to the guidance contained in HBN 40 – 'Common activity spaces, Vol 2, Corridors'. Further information is provided in HTMs 56, 58 and 61.

Fittings and finishes

4.11 Designers should aim to create an interior which is comfortable and pleasant to look at. The choice of fittings and furniture should form an integral part of the designing process and should be co-ordinated within the overall design scheme. Fixtures, fittings and furniture with sharp corners are a common cause of injury and should be avoided. Finishes, including floor coverings, should be functional and be compatible with the need for comfort, cleanliness and safety. The quality of finishes should, in general, conform with the standard of finishes specified for the rest of the hospital. Cleaning regimes should be considered when materials are selected.

Signposting

4.12 HBN 40 – 'Common activity spaces, Vol 2, Corridors', and the Health Signs Manual issued in November 1984 as HTM 65, should be consulted for general guidance.

Colours

4.13 Colour can influence the morale of patients and staff, and can be used to help patients to orientate themselves and to recognise particular rooms more quickly; thus, for example, all WC doors could be painted the same colour. The overall tone should be light with some stronger accents. Light-coloured surfaces assist with visibility of radiographs. Unprocessed films are more easily visible on dark surfaces. Most people prefer light, middle-range colours to dark ones. Accurate assessment of the colour of a patient's skin is of clinical importance; surface colours should not distort the colour rendering of light sources. The choice of colours also affects the lighting design and for this reason recommended surface reflectances are included in Activity DataBase A-Sheets.

Economy

4.14 The planning of hospital buildings requires design solutions which not only satisfy functional requirements but also ensure maximum economy in respect of both capital and running costs. Due weight must therefore be given to the questions of space provision, maintenance (including cleaning), energy consumption and staffing requirements.

4.15 Planning should ensure that spaces are used as intensively as possible and are not unnecessarily duplicated. Economical space provision can be achieved by planning for spaces to be used more intensively for a particular purpose. This means that the amount of space for a service or group of services should be no more than is needed for the anticipated workload, staffing levels and available revenue allocation.

4.16 In order to ensure that there is no over-provision of new accommodation, project teams should first evaluate the utilisation of similar existing facilities in relation to their workload and staffing.

Internal environmental considerations

4.17 This section enlarges upon general environmental considerations; particular aspects are dealt with in Chapter 5.

Natural and artificial lighting

4.18 The design of windows must reconcile different needs. In addition to the various statutory requirements, the following aspects also require consideration:

a. illumination and ventilation;

b. insulation against noise;

c. thermal loss or solar gain;

d. the prevention of glare;

e. the provision of a visual link with the outside world;

f. radiation protection;

g. patient privacy.

4.19 Design should ensure that it is possible for cleaners to have easy access to the inside and outside of windows. Guidance on types of window and on the safety aspects is available in HTM 55 – 'Windows'.

4.20 Decor should be light and pleasant. Natural lighting is essential to the well-being of patients. The provision of a comprehensive artificial lighting installation is also essential; it makes an important contribution to the aesthetic appeal of the department. It should be possible to vary the level of illumination to suit functional activities. Task lighting of the required intensity with low-contrast glare-free background illumination should be provided. All lighting should have suitable colour rendering characteristics.

4.21 Orientation is an important consideration in any site development scheme. Sunlight enhances colour and shape and helps to make a room bright and cheerful. Glare can be reduced by attention to the detail of window design, and can be controlled by curtains or blinds. This is a particular requirement for diagnostic rooms. The harmful effects of

undesired solar gain can be mitigated by external screens – a costly solution – or by architectural detail of the shape of windows and depth of reveals. Properly controlled solar gain contributes to energy efficiency.

Ventilation

4.22 Natural ventilation is usually caused by the effect of wind pressure. It will also occur to some extent if there is a temperature difference between the inside and the outside of the building. This thermo-convective effect frequently predominates when the wind speed is low and will be enhanced if there is a difference in height between inlet and outlet openings. Ventilation induced by wind pressure can promote high air change rates through a building if air is able to move freely within the space from the windward to the leeward side of the building.

4.23 Internal partitions, fire compartment walls and closed doorways can however often impede the flow path, and when this happens the process will be more dependent on single-sided ventilation. Nevertheless, even with this degree of obstruction to air movement, acceptable ventilation may still be obtained without window openings which would prejudice safety, security or comfort. Some types of window, for example vertical sliding, can enhance single-sided air exchange by temperature difference, and these will improve the overall rate of natural ventilation in protected or sheltered areas where the effect of wind pressure is likely to be minimal. Consideration is also needed regarding the degree of obstruction to natural ventilation which may occur in spaces such as diagnostic rooms where doors are kept closed for radiation protection and patient privacy. This also applies where curtains or blinds are used to dim ambient lighting levels for image viewing purposes. Section 2.3 of HTM 55 – 'Windows', BS5925 – 'Code of practice for design of buildings' and CIBSE Symposium 'Natural ventilation by design (2.12.80)' provide further information.

Noise

4.24 Any unwanted sound is a noise. Careful consideration should be given to ensuring a quiet environment for patients. Sound should be isolated and absorbed at source, where possible, with acoustic materials; it may be reduced by the use of soft floor coverings, curtains and other materials. On the other hand, a department can be too quiet; indeed a low level of background sound can assist privacy.

4.25 Adequate auditory privacy in offices and diagnostic rooms must be ensured. Telephones need special consideration in respect of both noise and auditory privacy.

Non-smoking on NHS premises

4.26 Health Circular HC(85)22 dated May 1985 – WHC(85)31 dated June 1985 in Wales – provides guidance about smoking on health premises. While recognising that the responsibility for determining local policies rests with the health authority, the circular recommends that smoking should be restricted as far as is practicable and, where it is permitted, confined to specially designated areas which are clearly signposted. In such areas ventilation should be sufficient to prevent discomfort to non-smokers and the spread of odours to other areas of the premises.

Design features

4.27 Patients' physical limitations impose special demands on internal design and fittings. Reference should be made to the ergonomic drawings in HBN 40 – 'Common activity spaces' Vols 1–4.

4.28 Doorways should be wide enough to allow clearance for people using walking aids and for wheelchairs. In some parts of the department, door openings must be wide enough and high enough to allow the passage of beds and attached equipment, for example orthopaedic attachments and drip poles. Lever handles if fitted should be 900 mm above floor level. When glazed doors are provided, the size and height of the glass panels should be appropriate to requirements for visibility, privacy and radiation protection. Fire regulations may require that electromagnetic door retainers be fitted; floor-mounted retainers should not obstruct traffic. In an emergency it must be possible to gain access to occupied WC and changing cubicles from the outside (see SIB(85)60). Doors should be fitted with easigrip bold handles. Bi-fold doors are not suitable. Because lead-lined doors are much heavier than ordinary doors, attention must be paid to selecting appropriate ironmongery.

4.29 Reference should be made to HTM 59 – 'Internal door sets' and HTM 59 – 'Ironmongery' for information on suitable components and for further guidance.

4.30 Other features requiring special consideration:

a. washbasins should be strongly fixed so that they can be used by patients for support; be located at a suitable height for ease of access by patients seated in a chair or wheelchair; and should not be supported by legs. Short-lever-action taps are more easily used by patients (see HTM 64 – 'Sanitary assemblies');

b. mirrors and shelves should be fixed at heights suitable for both wheelchair and standing users. Shelves should be placed near mirrors, but neither should be placed over basins;

c. aids for lifting and moving patients must be compatible with other equipment. Space in the treatment and diagnostic areas must be sufficient to allow effective use and easy manoeuvre of aids for lifting and moving patients.

Disabled people

4.31 It is essential to ensure that suitable access and facilities are provided for disabled people who have problems of mobility and orientation. This includes wheelchair users, those who for any reason have difficulty in walking and those with a sensory handicap such as a visual or hearing impairment. Authorities are reminded of the need to comply with the provisions of:

- the Chronically Sick and Disabled Persons Act 1970;
- the Chronically Sick and Disabled Persons (Amendment) Act 1976;
- the Disabled Persons Act 1981;
- the Disabled Persons (Services, Consultation and Representation) Act 1986;
- the Building (Disabled People) Regulations 1987.

4.32 Attention is also drawn to BS5810 of 1979 – 'Access for the Disabled to Buildings' (under review). One of the effects of the 1981 Act is to apply this British Standard to premises covered by the 1970 Act, which includes those open to the public. Practical guidance for complying with the Building (Disabled People) Regulations is issued by the Department of the Environment under Approved Document "M": Access for the Disabled.

4.33 Project teams are encouraged to refer to Health Building Note 40 – 'Common activity spaces, Vol 4, Designing for disabled people'. This gives guidance and a set of ergonomic Data Sheets on access, space and equipment relating to disabled people in health buildings.

4.34 Where a payphone is provided in a radiology department, the handset should be fitted with an inductive coupler to assist people using a hearing aid. Consideration should be given to mounting the payphone at a height suitable for a person in a wheelchair.

Privacy

4.35 The design of the accommodation must preserve the dignity and privacy of patients, particularly where men and women are treated in adjacent areas and share certain accommodation and circulation spaces. These must be reconciled with the need for unobtrusive observation which is vital for the care of the patient.

Upgrading or adaptation of existing buildings

4.36 The standards set out in this guidance essentially apply to the provision of accommodation by new building and it is not intended that they should be applied retrospectively to existing stock. However, the principles are equally valid and should be applied, so far as is reasonably practicable, when existing accommodation is being upgraded or new accommodation is being constructed within an existing building which may previously have been used for other purposes. In such cases, the aim should be to meet HBN standards wherever possible although it is recognised that compromises will inevitably have to be made.

4.37 The cost of upgrading work should conform to the guidelines indicated in the Department's WKO letter (81)4 issued in July 1981. The guidelines take into consideration the estimated life of the existing building and the difference in cost between upgrading a building and new building.

4.38 Before any decision is made to carry out an upgrading project, consideration must be given to the long-term strategy for the service, the space required for the new service, and the size of the existing building. Regard must also be paid to the orientation and aspect of the building and the adequacy and location of all necessary support services.

4.39 If there emerges a *prima facie* case for upgrading, a thorough analysis of all functional and physical conditions of the existing building should be undertaken.

4.40 When comparing the cost of upgrading or adapting an existing building to that of a new building, in addition to the building cost due allowance must be made for the cost of relocating people, demolition and salvage costs, disruption of services in a phased project, and the temporary effects on functioning of areas affected by upgrading.

4.41 The check of physical and other aspects of existing buildings should include:

a. availability of space for alterations and additions;

b. type of construction, with particular reference to the requirements for radiation protection;

c. insulation;

d. age of the buildings, and condition of fabric, for example external and internal walls, floors, roofs, doors and windows, which may be determined by a condition survey;

e. life expectancy and adequacy of engineering services, and ease of access and facility for installation of new wiring and pipework, if required;

f. the height of ceilings (high ceilings do not necessarily call for the installation of false ceilings which are costly and often impair natural ventilation). Diagnostic rooms require a ceiling height suitable for the installation of imaging equipment (see Appendix 1);

g. changes of floor levels which may be hazardous to disabled people (see paragraphs 3.42 and 4.31–4.34);

h. fire precautions (see paragraphs 4.4–4.7);

j. physical constraints to adaptation such as load-bearing capacity of walls, floors and columns;

k. ease of access for heavy equipment.

4.42 Having decided that existing premises are suitable for upgrading or conversion, the main requirement will be to assess how best the accommodation can be adapted so as to facilitate good practice.

4.43 The main environmental factors which should be considered are the same as for new building. Upgradings must conform to current safety and other statutory regulations. It is very difficult to estimate the fire resistance of floors, walls and doors of existing buildings.

4.44 This summary of the main aspects of upgrading is necessarily general in character and it is recognised that each upgrading project will present its own individual problems. In many instances compromises may have to be made between HBN standards and what it is possible to achieve. Upgradings should be functionally sound – not merely cosmetic – and appropriate for the projected needs of patients and staff for a number of years to come.

Information technology in the NHS: provision for Automatic Data Processing (ADP)

4.45 Information technology has a central role in health management. Use of computers and telecommunications – and indeed the rate of technological innovation – continues to increase. The implications for building project teams are threefold: first, a requirement for the housing of the computer(s); second, a requirement for the provision of ducts and wireways for interconnecting and transmission cabling; and third, sufficient space and suitable power supplies for modems, VDTs, printers and associated software and stationery. Even if the introduction of automatic data processing (ADP) is not proposed at the time that the project team completes its brief, it will be advisable to design in such a way that equipment can be introduced easily and quickly at some later date.

4.46 There are two principal matters of concern: visibility and noise. VDTs are now a familiar sight and it will easily be appreciated that they cannot be reduced beyond a certain size. Consequently, sufficient and convenient space must be provided for them; also, since the brightness of the text displayed on the screen cannot exceed a certain limit, special attention must be given to the ambient lighting to ensure that the contents of the screen are legible. Space will be required in front of the screen for a keyboard. The problem of noise arises from the alternative ways of obtaining data from the computer, via printers which can provide printed paper copies of the data in the computer. Much has been done to reduce noise and the latest laser printers work reasonably silently. Noise may not be too noticeable during normal working hours, but during quiet hours it will probably not be acceptable unless special arrangements are made, such as the positioning of the printer at a site remote from patient areas.

4.47 Computing expertise is now widely available in the NHS and project teams should ensure that, at an early stage, they inform themselves concerning current and projected local computing policies, and that their proposals conform.

Computer applications in radiology data storage

4.48 Computer management systems are now in common use in radiology departments. At least part of the patient data storage is likely to use a system with computer terminals located in such areas as reception, current film store, sorting and collating, administrative and reporting areas. The overall space required for these activities may be affected by the type of system adopted and the degree to which computerisation is used. Systems provide operational convenience and efficiency as well as a substantial increase in both management and clinical data available. Installation of any computer system should be coordinated with other systems within the hospital, especially the health records department, to ensure the free interchange of data. There should also be sufficient flexibility in any departmental system to allow upgrading of both hardware and software. Project teams should also assess the progress made towards full digital imaging which is currently being developed. It should be borne in mind that the power requirements and cable distribution arrangements for all such systems will affect the engineering requirements of the radiology department.

Critical dimensions

4.49 The figures in Appendix 1 contain information on critical dimensions for some of the activities whch are mentioned in this Note and do not appear in HBN 40 – 'Common activity spaces', Vols 1–4.

Works Guidance Index

4.50 While this Note provides guidance that is current at the time of publication, it must be borne in mind that there are wider considerations associated with radiation medical gases, high-risk infectious disease, fire, energy conservation, etc covered by other published guidance which must also be taken into account. Additionally, some aspects of the guidance in this Note may from time to time be amended or qualified. Project teams should first check with the current edition of the Works Guidance Index. Because the Index is published by the Department of Health in May each year and updated only in September and January, project teams should ensure that they investigate the possibility of changes not included in the latest published version.

5.0 Engineering services

Introduction

5.1 This chapter describes the engineering services contained within this department and their integration with the systems serving a whole site. Its purpose is not to inhibit the design solution but to acquaint the engineering members of the multidisciplinary design team with the design criteria, material specifications and reference data needed to meet the functional requirements.

5.2 Documents referred to by number, for example[10] are listed at the end of the chapter. They are numbered in order of first appearance, repeated references retaining the same number.

Model specifications

5.3 A series of model specifications for the specialised engineering services in health buildings have been issued nationally and are sufficiently flexible to reflect local needs. The cost allowance for the engineering services in each functional unit of this accommodation is based on the qualities of material and workmanship described in the relevant parts of the model specifications.

Economy

5.4 Engineering services are a significant proportion of the capital cost and thereafter remain a continuing charge on revenue budgets. The project design engineer should ensure not only the utmost economy in initial provision, consistent with meeting the functional requirements and maintaining clinical standards, but also the optimum benefit from the total financial resources these services are likely to absorb during their lifetime.

5.5 Where alternative design solutions are available, their consequential capital and running costs should be compared using option appraisal techniques[1] so that due consideration is given to the need for, and the costs of, maintenance and the eventual replacement of plant and equipment.

5.6 The economic appraisal of alternative design solutions should include the heat conversion and distribution losses at the point of use. Where buildings are located remote from the development's load centre, these losses can often equal the useful energy consumed.

5.7 In any new project, consideration should be given to energy management and the facilities offered by a whole hospital control system to enable some measure of energy accounting to be exercised at department level.

5.8 In view of the increasing costs of generating heat energy, consideration should be given to the economics of appropriate equipment for recovering some of the value of the energy which would otherwise be discharged by mechanical ventilation systems. The programmed turning off, or reduction, of heating and ventilation in those spaces used only for part of the day should also be considered.

Maximum demands

5.9 User demand on engineering services is often difficult to predict, but experience indicates that services designed for simultaneous peak conditions are seldom fully utilised in practice. The estimated maximum demand and storage requirement (where appropriate) for each engineering service in this accommodation will need to be assessed individually to take account of the range, size and shape of the functional units, geographical location, operational policies and intensity of use. As a guide, and for preliminary planning purposes only, the table below shows the estimated maximum demands for a radiology department comprising eight diagnostic rooms, a computed tomography suite, an ultrasound suite and a nuclear medicine imaging suite.

Service	Typical maximum demand	Notes
Heating/ventilation/DHWS (kW)	180	
Domestic HWS (litre/sec)	2.0	Storage 1800 litres (2 hour recovery)
Cold water (litre/sec)	2.4	Storage 7000 litres (24 hours)
Supply ventilation (m^3/sec)	3.0	
Extract ventilation (m^3/sec)	3.0	Clean and dirty
Electrical (kVA)	69	Includes essential 36 kVA
Medical gases (litre/min)		
Oxygen	80	
Nitrous oxide	90	
Vacuum	730	
Fuel gas	–	No requirement
Steam	–	No requirement

Space requirements for services

5.10 The satisfactory performance of plant in health care buildings is particularly important and the design should allow for ease and safe means of access and space for necessary frequent inspection and maintenance, and for eventual removal and replacement. As far as practicable, however, this access should be protected from unauthorised entry. In a radiology department this access also must not compromise the radiological protection provided for diagnostic rooms.

5.11 Recommended spatial requirements for mechanical, electrical and public health engineering services in health buildings are given in HTM 23[2]. The information in HTM 23 is specifically intended for use during the initial planning stages when precise dimensional details of plant are not available.

5.12 Wherever possible, the distribution of mechanical and electrical services to final points of use should be concealed in walls and above ceilings. Heat emitters should be contained within a 200 mm wide perimeter zone under window sills and critical dimension should be taken from the boundary of this zone. For costing purposes the 200 mm band, which includes the floor area occupied by minor vertical engineering ducts, is included in the building circulation provision.

Activity Data

5.13 User requirements, environmental conditions and equipment arrangements, as described in the Activity Data Sheets (see Chapter 7), should be referred to when positioning service components and outlets. Where the latter are for patient operation, they should be of the simplest pattern designed to inhibit interference.

Safety

5.14 Section 6 of the Health and Safety at Work etc Act 1974[3], as amended by Schedule 3 of the Consumer Protection Act 1987[4], imposes statutory duties on all persons who design, manufacture, import, supply, install or erect "articles for use at work". One of the requirements of this Section is to ensure, so far as is reasonably practicable, that the article is so designed and constructed that it will be safe and without risks to health at all times when it is being set, used, cleaned or maintained by a person at work. All parts of engineering systems are covered by the term "articles for use at work" and designers of these systems for health care premises must therefore fulfil their statutory obligations.

Fire precautions

5.15 Design guidance relative to the fire precautions in new hospitals is given in HTM 81[5]. Technical information concerning the design and specification of fire detection and alarm systems is detailed in HTM 82[6] which also replaces or modifies certain clauses of BS5839 Part 1[7] to meet the needs of health care premises. General advice on fire prevention, including the storage of flammable materials, is given in HTM 83[8].

5.16 The design of the engineering services should accord with the recommendations in the above HTMs and the engineer should verify his proposals in accordance with the procedure described in paragraph 4.6.

Noise

5.17 Excessive noise in the individual areas, whether internally or externally generated and transmitted, can adversely affect the operational efficiency of the department and can cause discomfort. The limits and means of control advocated in Hospital Design Note 4[9], including its revisions[10], and the means of control given in Engineering Data Sheet DH(1)[11], should provide an acceptable acoustic environment. In addition to designing for control of noise levels, there may also be a need to ensure speech privacy, that is, that confidential conversation is unintelligible in adjoining rooms or spaces. This will typically, but not exclusively, be required in examination rooms and interview rooms. The acceptable noise level and any requirement for speech privacy, where applicable, in the individual spaces in this department is shown on the Activity Data A-Sheets.

Control access

5.18 Primary engineering distribution control and isolation devices should be protected against unauthorised operation, for example, switchgear and fuse-boards should be housed in secure cupboards. They should be located in circulation areas rather than working areas and, where appropriate, should easily and safely be accessible for staff operation.

Engineering commissioning

5.19 It is most important that engineering services should be fully commissioned. HTM 17[12] describes the requirements which should be included in the design and construction contract documents. Flow measurement and proportional balancing of air and water requires adequate test facilities, for example orifice plates, venturi valves, etc to be incorporated at the design stage.

MECHANICAL SERVICES

5.20 The mechanical services include the provision of heating, ventilation, hot and cold water supplies and medical gases. For cost allowance purposes the distribution of the heating, hot and cold water, medical gases, and ventilation systems is deemed to commence at their point of entry into the department and includes pipework, ductwork, fittings, controls and connections to equipment and terminal outlets. The cost allowance also includes for an appropriate proportion of the ventilation plants and associated controls serving this department. An optional cost allowance is provided for those circumstances, described in paragraph 5.33, when air cooling may be required.

5.21 For environmental requirements in individual spaces, reference should be made to the Activity Data Sheets. Recommended room temperatures, air change rates, hot water service temperature, etc are grouped under "Technical Design Data" on each A-Sheet. The B-Sheet gives the disposition of engineering outlets for the activities described.

Heating

5.22 General space heating requirements can usually be met by low-pressure hot water radiators operating as a sub-system from the primary heating distribution system. Due to the complexity of electrical engineering services at high and low level, underfloor and ceiling heating are inappropriate to this department.

5.23 Radiators should be of the low surface temperature type to ensure that the surface temperature does not exceed 43°C. Exposed heating pipework accessible to touch should be insulated. Radiators should normally be located under windows or against exposed walls, with sufficient clear space between the top of the radiator and the window sill to prevent curtains reducing the output and adequate space below to allow cleaning machinery to be used. Where a radiator is located on an external wall, back insulation should be provided to reduce the rate of heat transmission through the building fabric.

Temperature controls

5.24 To facilitate overall temperature control, the heating system flow temperature should normally be varied via an external compensator, and thermostatic radiator valves should be installed on all heating appliances. These valves should be of robust construction and selected to match the temperature and pressure characteristics of the heating system. The thermostatic head, incorporating a tamper-proof facility for presetting maximum and minimum room temperature, should be controlled via a sensor located integrally or remotely as appropriate.

5.25 The rate of rise or fall of temperature within the diagnostic room in the nuclear medicine imaging suite should be restricted to 4°C per hour if damage to the expensive crystal detector within the gamma camera is to be avoided. Suitable local temperature controls, which may have to override the "silent hours" set-back facility described in the next paragraph, should be provided.

5.26 Temperature controls, preferably incorporating an optimum-start feature, should include a "silent hours" temperature set-back of approximately 10°C. During commissioning trials this should be adjusted to the lowest level consistent with providing anti-condensation heating. Time-switches should be provided to select normal running or "silent hours" modes for the heating and ventilation systems and their temperature controllers, with the facility to control separately those services to those parts of the department associated with "out of normal hours" working. The operational status of the heating and ventilating systems should be indicated by pilot lamps in, or adjacent to, the space concerned or at the reception desk for general systems, for example diagnostic rooms. Manual overrides should consist of a "continuous on" for areas associated with "out of normal hours" working, and a "2 hour on" facility for the remainder. These manual overrides should be located at the reception point or other suitable location and be provided with labels clearly describing their function. The timing routine of the main supply and extract fans should also apply to other local extract fans serving ancillary accommodation within the same areas.

Ventilation – general requirements

5.27 Recommendations for the ventilation of individual spaces in this department are shown on the Activity Data A-Sheets.

5.28 Mechanical ventilation systems are expensive in terms of capital and running costs and planning solutions should be sought which take maximum advantage of natural ventilation. It is acknowledged that planning constraints imposed by the building shape and/or functional relationships of specific spaces will invariably result in some measure of enclosed internal areas. Ventilation costs can however be minimised by ensuring that wherever practicable, core areas are reserved for rooms that require mechanical ventilation irrespective of whether their location is internal or peripheral. Examples are: sanitary facilities, dirty utility, treatment rooms and rooms whose clinical or functional requirements have specific environmental needs and where, for reasons of privacy and absence of solar gain etc, windowless accommodation is acceptable. Other spaces appropriate to core areas are those which have only transient occupation and therefore require little or no mechanical ventilation. Examples are circulation and some storage areas.

5.29 Air movement induced by mechanical ventilation should be from clean to dirty areas, where these can be defined, and should generally be arranged to encourage uniform air movement within the space. The design should allow for an adequate flow of air into any space having only mechanical extract. Transfer grilles should be provided in doors or walls to connect such spaces to either naturally ventilated corridors or other spaces with mechanical air supply. Such arrangements, however, should avoid the introduction of untempered air and should not prejudice the requirements of fire safety, radiation protection and speech privacy.

5.30 The fresh-air supply should be tempered and filtered before being distributed via high-level grilles with output profiles designed to avoid discomfort to lightly-clad patients. Ventilation supply plant should include air filters having a minimum arrestance of 85%, and a minimum average dust spot efficiency of 25%, when tested in accordance with BS6540 Part 1[13]. Filters must be readily accessible for replacement and maintenance purposes and provided with a pressure-differential indicator; coarse pre-filters may be necessary where the intake air is exceptionally polluted. Heater batteries should be sized for the ventilation requirements only, that is, not the building fabric loss. All heater battery coils and filters should be provided with frost protection.

5.31 A separate extract system will be required for "dirty" areas, for example sanitary facilities, and a dual motor/fan unit with an automatic changeover facility should be provided to ensure that these rooms are always maintained at a negative pressure when the department is in use.

5.32 External discharge arrangements for extract systems should be protected against back pressure from adverse wind effects and located to avoid re-introduction of exhausted air into the building through air intakes and windows.

Ventilation of diagnostic rooms

5.33 The possibility of excessive heat emission from some diagnostic equipment used for CT scanning, fluoroscopy, ultrasound or other special and ofter prolonged procedures, together with the need for staff to wear heavy protective clothing during some procedures, may require that the supply air to these rooms be mechanically cooled (see paragraph 3.23). Where this option is required the plant capacity should be limited to that necessary to maintain an internal temperature of 25°C when the external ambient is 28°C. Where deep planning of other continuously occupied spaces, for example offices, is unavoidable there will also be occasions when acceptable levels of comfort can only be maintained by air-cooling. Deep planning solutions however will be exceptional and no provision for this feature has been included in the Departmental Cost Allowances.

Ventilation of film processing areas

5.34 Spaces used for film processing, silver recovery and associated automatic mixing and dispensing of processing chemicals, should be mechanically ventilated to control (within the recognised occupational exposure limits) the levels of potentially harmful chemical emissions in an operator's breathing zone. In addition to achieving the recommended ventilation rates, it is important that the system is designed to optimise dilution of contaminants throughout the spaces, without compromising extract arrangements at the equipment. Supply air to these spaces may be provided by transfer grilles from adjoining radiodiagnostic rooms. Wherever practicable, film processors should be connected directly to the mechanical extract ventilation dedicated to this equipment, which should discharge direct to external atmosphere (see also paragraph 5.32). The materials selected for extract ductwork and accessories should be suitable to endure acidic vapour contaminants. Current working practices usually require the chemical mixing units to be located in the film processing area in reasonable proximity to the processors they serve. Silver recovery systems may also be sited within this space unless bulk storage of used fixer is employed (see Appendix 8). Although chemical mixers and silver recovery vessels can be expected to be supplied with tight lids, local mechanical extract should be provided, including a low-level grille close to the recovery equipment, to deal with potential sulphur dioxide emissions which are heavier than air and which do not readily mix with, or conform to, air movement patterns. All other chemical emissions from film processing (the principal component being acetic acid vapour) can be expected to conform to the design intention for air movement control within these mechanically ventilated spaces.

5.35 A well-documented problem can arise in film processing areas in which "static marks" are evident on processed films. These are created by sparks of static electricity induced onto the film surfaces in an atmosphere of low relative humidity. Local humidity control may be necessary to ensure the recommended lower limit if such a condition cannot be sustained by the central supply air ventilation plant. An optional cost allowance is provided for this feature.

Ventilation controls

5.36 Supply and extract ventilation systems should include indicator lamps to confirm the operational status of each system. Where a system is provided for a particular space, the indicator should be in, or immediately adjacent to, that space and local controls should be provided as appropriate. In the case of a more general system of ventilation, for example WCs, the indicator should preferably be located at the reception desk or other suitable location. Where manual controls are available for staff use, they should be provided

with labels clearly defining their function. Where manual overrides of time switches controlling the running periods of ventilation plants are provided, they should be grouped with the temperature control overrides described in paragraph 5.26.

Hot, cold and drinking water services

5.37 The domestic hot water supply should be taken from the general hospital calorifier installation at an outflow temperature of 60°C ± 2.5°C, and distributed to all outlets so that the return temperature at the calorifier is not less than 50°C.

5.38 Guidance concerning cold water supply pipework and distribution systems is given in HTM 27[14]. For frost protection purposes, and to prevent condensation staining decorative finishes, all cold water pipework, valves and flanges should be insulated and vapour sealed.

5.39 The particular pressure and temperature requirements for the water supply to film and other image processors should be confirmed with the manufacturer. A minimum pressure of 1.03 bar (15 psi) is normally acceptable and the cold water temperature should not exceed 20°C. Processors should incorporate an automatic control valve to interrupt the flow of water when the processing cycle is complete, which complies with the requirements of the current Model Water Byelaws[15].

5.40 To control Legionellae, the water services should be designed, installed and commissioned in accordance with the recommendations in the DHSS Code of Practice[16]. See also Health Guidance Note – '"Safe" hot water and surface temperatures'[17].

Piped medical gases and vacuum

5.41 Information regarding piped medical gases is given in HTM 22[18] and any subsequent published amendments. The location of outlets is indicated on the Activity Data Sheets.

5.42 In any special procedures room where nitrous oxide is used, provision should be made for active scavenging of waste anaesthetic gases in accordance with the recommendations of BS6834[19].

ELECTRICAL SERVICES

5.43 The electrical installation will include main intake switchgear, the main supply feeders for X-ray equipment, the wiring and equipment for lighting, power and environmental plant, together with the equipotential bonding of extraneous metalwork. Extensions from the hospital central systems for telephones, clocks, fire alarms and staff location services, together with staff call systems, will also be required. These installations should comply in all respects with the current IEE Regulations for Electrical Installations[20] and conform to the requirements of HTM 7[21].

5.44 Reference should be made to the Activity Data Sheets for the recommended levels of internal illumination and the disposition of outlets for power, telephones, call systems and clocks, etc in individual spaces.

5.45 The point of entry for the electrical supply will be a departmental switchroom housing the main isolators and the main distribution equipment. The switchroom will also be the distribution centre for subsidiary electrical services and, wherever possible, all equipment should be mounted at a height to give easy access from a standing position. The switchroom should be positioned so as to minimise the cost of cabling required to serve the department.

Electrical installation

5.46 The electrical installation in occupied areas should be concealed, usually using PVC insulated cable in screwed steel conduit or trunking, but, in certain circumstances, mineral insulated copper-covered cables may be necessary. External installations should comprise PVC insulated cables in galvanised screwed steel conduit with fittings of weatherproof pattern. Steel conduit and trunking wireways for communication and data systems should also be concealed whenever possible.

Electrical interference

5.47 Guidance concerning the avoidance and abatement of electrical interference is given in HTM 14[22]. Fluorescent luminaires (lighting fittings) should comply with BS5394[23] and dimming devices should comply with BS800[24].

5.48 Care should be taken to avoid mains-borne interference and electrical radio frequency interference affecting computers and other electronic equipment used here or elsewhere on the hospital site.

Lighting

5.49 Practical methods of lighting the various functional spaces are contained in the CIBSE Lighting Guide LG2[25]. The choice of luminaire should take account not only of the requirements for light distribution and visual comfort appropriate to the space, but also the operational efficiency of the light source used. Luminaires should be of a type which is easily cleaned and maintained, as well as being manufactured and tested in accordance with the requirements specified in the relevant sections of BS4533[26]. Their location should be readily accessible for lamp changing and maintenance, with the overriding requirement that the recommended standard of illuminance

is provided to the task areas. Luminaires using fluorescent lamps should be installed when artificial lighting is required for long periods or where areas are devoid of natural light; intermittently-used luminaires may be fitted with incandescent or compact fluorescent lamps.

5.50 It is essential that fluorescent lighting in clinical areas is derived from one of the recommended types of lamp having suitable colour rendering characteristics. In such areas the colours chosen for walls, floors and ceilings should be carefully selected; architects and engineers should collaborate to ensure that the decorative finishes are compatible with the colour rendering properties of the lamp and the spectral distribution of the light source is not unduly altered. HN(85)20[27] – in Wales, CAWO (85)3 – describes some high-efficiency fluorescent lamps with good colour rendering properties which are also suitable for general use within this department.

5.51 Dimming of room lighting will be extensively used in this department in the locations indicated on the Activity Data Sheets. In spaces where the control of lighting is by local on/off switches, these should be provided in sufficient numbers to allow variation in lighting options (for example, reduced levels of illuminance when circumstances permit) and to encourage energy conservation. This is particularly relevant in spaces where, because daylight is restricted, supplementary artificial lighting is required for long periods in areas away from windows. However, it is important that excessive contrast with adjacent areas should be avoided.

5.52 In areas where VDTs, including diagnostic consoles, are to be used, the lighting should be designed to avoid bright reflections on the screen and to ensure that the contents of the screen are legible. Further guidance can be found in CIBSE Lighting Guide LG3[28].

5.53 In addition to the general lighting a safe-light installation should be provided in darkrooms and (to facilitate recovery of unexposed film) in areas containing automatic film loaders or dispensers. The safe-light installation in darkrooms should be connected via an interlock switch to ensure that if the unused film hopper is opened the general ("white") lighting is extinguished. An "In use" warning sign should be provided outside the entrance to darkrooms. The sign should be automatically illuminated when the safe-light system is in use.

Lighting of diagnostic rooms

5.54 The ceilings of these rooms should incorporate equipment support facilities (see paragraph 3.35) consisting of a grid of uniformly spaced universal type support channels of a proprietary nature, the dimensions between which are coordinated to accommodate recessed modular fluorescent luminaires. Such an arrangement allows a compromise between the masking of lighting by mobile ceiling-mounted equipment, and the need for well-positioned task illumination. The lamps in the modular luminaires should be circuited and switched to provide two stages of intensity (100% and 50%), and for lower levels of illumination the luminaires should also incorporate a high-frequency fluorescent lamp controlled by a single dimming device. These overall arrangements, with all lighting control and isolation adjacent to the X-ray control console, and with the main lighting two-way switched at the doorways, will readily accommodate relocation of luminaires when changes are made to the diagnostic equipment.

5.55 Mobile examination lamps should operate at extra low voltage, be totally enclosed and should be equipped with a heat filter. The temperature of external surfaces should be such as to avoid injury to patients and staff. These luminaires should comply with the requirements of BS4533, Section 102.55[26] and be in accordance with the performance specification of Type A included in BS4533, Section 103.2[26].

Illuminated signs

5.56 At each entrance to a radiodiagnostic room, except entrances used only by patients under the direct control of staff already inside the room (for example those from walk-through changing cubicles), a safety sign and a warning lamp should be provided in order to comply with the statutory requirements for radiological protection. The warning lamp should give a clear indication in red when it is energised and may incorporate the legend "Do not enter", visible only when illuminated. All warning lamps should have incandescent filaments energised from a suitable power source within the room and switched via appropriate devices interlocked with the operation of the diagnostic equipment.

Lighting of corridors, reception and waiting areas

5.57 In reception, waiting and circulation areas, colour graphics and lighting should be coordinated to create a calm and welcoming atmosphere while also contributing to the safe movement of patients throughout the department. The careful selection of ceiling finishes and decor, and the judicious location of ceiling luminaires and illuminated signs to indicate a corridor junction or a particular facility, can produce a more domestic-type ambience.

5.58 The lighting of corridors and circulation spaces not specifically covered by Activity Data Sheets should be in accordance with the guidance contained in HBN 40 Vol 2[29].

Controlled Drugs cupboard

5.59 In compliance with HC(77)16[30] – in Wales, WHN(77)32 – a red indicating lamp should be provided on

each Controlled Drugs cupboard. Remote indicating lamps should be provided, where appropriate, outside the doorway to the room in which the cupboard is located, at the corresponding nurse base and, after working hours, in a continuously manned area external to the department. The lamps should be interlocked with the cupboard to give visual indication when the cupboard is unlocked and should be supplied from an essential circuit. For further information see HTM 63 – 'Fitted Storage Systems'[31] and its associated specification for electrical services. The cupboard should be in accordance with BS2881[32].

Socket-outlets

5.60 Sufficient 13 amp switched, shuttered socket-outlets, connected to ring or spur circuits, should be provided to allow all portable appliances likely to be used simultaneously to be individually supplied. Activity Data Sheets indicate specific locations for the outlets associated with individual activities; the installation of twin outlets should be considered where these activities occur in juxtaposition. In diagnostic rooms, recovery areas and wherever X-ray films are processed, reported on or stored, socket-outlet systems should be planned so that a supply is available in the space from at least two separately fused circuits of common phase.

5.61 Depending on local circumstances, consideration may need to be given to the quality of the electrical supply at socket-outlets serving computer equipment. It is envisaged that the circuits will be arranged so that regulators, filters or other specialised computer power supply equipment can readily be incorporated either initially or at a later date. The cost allowances do not include the supply and installation of any such auxiliary equipment.

5.62 Domestic cleaning appliances with flexible leads 9 m long should be assumed and socket-outlets, usually in corridors, should be provided to enable such machines to operate over the whole area of the accommodation.

5.63 Fixed appliances rated up to 13 amp should be permanently connected to double pole switched connection units and fused as required. Appliances rated in excess of this load, or those requiring a three-phase supply, should be permanently connected to separate final circuits from fuse-boards and independently switched.

5.64 Local switches or other means of isolation should be provided adjacent to electrical machinery and plant to ensure the safety of operators and maintenance staff.

5.65 Heating appliances, and automatically operated equipment, should be provided with indicator lights to show when the equipment is energised. Such indicators should be incorporated in the control panel of the apparatus, in the control switch or in the socket-outlet from which the apparatus derives its supply.

Electrical supplies to radiology equipment

5.66 The electrical supply connections to all classes of electromedical equipment, including radiology equipment, should comply with BS 5724[33] and the equipment itself should comply with this British Standard.

5.67 Advice on the power supply requirements for fixed and mobile radiology equipment is given in HTM 7[21]. Individual project requirements, including the relative arrangements of rooms within the department, will largely decide whether a radial or ring type feeder system is appropriate. While lower circuit impedance favours the ring circuit, difficulty in looping heavy current cables at the terminals of switchgear should be borne in mind. The sharing of final feeders between several diagnostic rooms should take account of the diversity of usage, with particular reference to exposure duration and frequency; the lowest diversity being accorded to the equipment used for fluoroscopy and special procedures. Power terminations within diagnostic rooms should consist of an isolator when connected to a spur feeder, and a fused switch when connected to a ring feeder.

5.68 The earth connection at the power termination should be suitable for the functional earth requirements specified by the radiology equipment manufacturer, and be arranged to receive a direct connection from the earth reference terminal which should be provided or designated in every radiodiagnostic room. The purpose, characteristics and performance criteria of an earth reference terminal in a radiodiagnostic room are described in the "protective earthing" section of the Department of Health's specification document TRS 89[34] relating to the supply and installation of equipment for diagnostic imaging and radiotherapy.

5.69 Numerous electrical interconnections are required between the separate components associated with a complete diagnostic room installation. Conduit and cable trunking should preferably be installed by the electrical sub-contractor, to a layout satisfying the requirements of the equipment supplier who will normally supply and install the interconnections. Some cables have limitations on maximum length and radius of bends, for example high-voltage cables.

5.70 While it is preferable for all the components associated with a diagnostic room to be located therein, the relative positions will depend on operational requirements and room features. Control consoles and control equipment cabinets, however, are usually located adjacent to or against perimeter walls. With these features in mind, the cable distribution may be accommodated in a perimeter floor duct located approximately 200 mm from the walls, from which spur ducts traverse the floor to island equipment or rise via wall-mounted units to terminate at cable trunking above the ceiling.

5.71 Floor trunking should be of the continuous-lid load-bearing variety of nominal 100 mm depth, and changes in direction of trunking should be provided with an internal angle gusset. All trunking lids when removed should give total access so that cables may be laid in, rather than drawn into, the trunking, without negating the possibility of drawing in individual cables during periodical maintenance by lifting lids only at angles or tees. Should it be necessary for trunking to pierce walls etc, there should be adequate straight sections on either side of the wall to enable preformed cable termination assemblies to be fed through such an opening without difficulty.

5.72 The surface finish of cable trunking visible within diagnostic rooms should be commensurate in quality with the equipment consoles and cabinets. Conduit or trunking routes piercing radiological barriers, for example diagnostic room perimeter walls, should be provided with adequate radiation shielding or dense in-fill material.

Emergency electrical supplies

5.73 Guidance on the provision of emergency electrical supplies is given in HTM 11[35] and the grade of standby lighting provision is shown on the Activity Data A-Sheets. Safety lighting in accordance with HTM 11[35] and BS5266[36] should be provided on primary escape routes.

5.74 All socket-outlets in reporting areas and in areas provided with Grade A standby lighting, together with the power supply to at least one film processing system and all communication, clock and alarm systems in this department, should be capable of being automatically transferred to the hospital standby generation system. One socket-outlet in selected diagnostic rooms should be capable of supplying a mobile X-ray unit at full power, during the periods that the normal mains supply is not available for any of the main X-ray equipment. It may not be possible for small generator sets (of 100 kVA rating or less) to provide full power to a mobile X-ray unit, even if the distribution circuit to the socket-outlet complies with HTM 7[21]. Regardless of the size of the generator it is advisable, therefore, to check with the standby generator set manufacturer that the set is capable of supplying the necessary mains current at the recommended maximum design value of total supply circuit impedance, and of supplying it for the required X-ray exposure period, without tripping the short-circuit protection provided at the generator set. It is even more important that this be checked if consideration is being given to the connection of any main X-ray unit to the generator.

Call systems

5.75 Patient/staff call points should be provided in all patient toilets and changing/recovery rooms. Each call unit should comprise a push-button or pull cord, reassurance lamp and reset switch.

5.76 Staff/staff (emergency) call points should be provided in all patient toilets, changing rooms, recovery rooms, diagnostic rooms and treatment rooms.

5.77 Call units should generally comprise a switch (pull to call, push to reset) and reassurance lamp. The audible alarm signal initiated by patients should operate for one second at ten-second intervals until cancelled with corresponding lamps lit continuously. The audible alarm signal initiated by staff should operate intermittently at half-second intervals, with corresponding lamps flashing on and off at the same rate.

5.78 A visual and audible indication of operation should be provided at the nurse base and repeated at the main reception point to give responding staff unambiguous identification of the call source. For use outside normal working hours, switching should be provided to transfer indication of an emergency call to the accident and emergency department or to an appropriate centrally-manned point.

5.79 All call systems should operate at extra-low voltage. Further general guidance is given in HTM 15[37].

Staff location system

5.80 The staff location system employed in the hospital should be extended to give adequate cover to this department. Guidance on these systems is given in HTM 20[38].

Telephones

5.81 Central telephone facilities for internal and external calls will normally be available and should be extended to serve this department in accordance with the requirements shown on the Activity Data Sheets. Telephones will normally be of the desk pattern. In recovery areas or adjacent to them, and in any diagnostic room in which a telephone is provided, they should be fitted with an indicating call-light and a bell or buzzer of subdued tone.

5.82 Guidance concerning the provision of telephone systems and equipment, including the telephone internal cabling distribution and telephone handsets, is given in HBN 48[39].

Intercom systems

5.83 A telephone system served by electronic exchange equipment should meet virtually all the internal communication requirements in this accommodation. However, due to the character of the diagnostic techniques

used during ultrasound examinations and in the CT scanning control room, it is usual to provide intercom stations controlled from the departmental reception point. This will permit "hands-free" speech contact between the receptionist and diagnostic staff in these rooms. These stations should be of the "duplex" type, with microphone and loudspeaker combined in a telephone-type instrument, with automatic voice switching and automatically convertible to "telephone mode" for privacy. The system should provide a minimum of two speech channels and incorporate all-call paging.

5.84 If project teams consider that their own operational policies may be better served by extending the above intercom system to other rooms in this accommodation, care should be taken to restrict correspondingly the number of telephones provided. Additional costs are likely to be incurred if this alternative approach is selected.

5.85 In those situations where certain diagnostic rooms are either reserved for, or primarily associated with, accident and emergency requirements, it may be appropriate to install in these designated rooms an extension from the intercom system which is provided for the functions of the accident and emergency department.

Wireways for data links

5.86 Wireways, which should be segregated from electrical power and telephone cabling distribution systems, will be required for signal cables interconnecting electronic equipment. These wireways should link all rooms:

a. where diagnoses are undertaken or viewed, for example diagnostic rooms and reporting areas;

b. where used films are stored and where patient records are processed;

c. where closed-circuit television or digital image transmission is envisaged.

5.87 Wireways will also usually be required for data links between the workstations in the reporting areas and between the main hospital computer and the reception desk. There may also be a requirement for data links between workstations in this department and other staff workstations elsewhere in the hospital, depending on the local policy for automatic data processing.

Electric clocks

5.88 Clocks should operate in conjunction with a master clock system. If such a system is not available, synchronous clocks should be installed using a common clock circuit suitable for future connection to a master system. Clocks should be installed only where they can be viewed by numbers of staff/patients/visitors.

Lightning protection

5.89 Protection against lightning should be provided in accordance with HTM 7[21], Engineering Data Sheet DB 2[40] and BS6651[41].

INTERNAL DRAINAGE

5.90 The primary objective is to provide an internal drainage system that uses the minimum of pipework and remains water- and air-tight at joints and connections, but is sufficiently ventilated to retain the integrity of water seals.

Design parameters

5.91 General design guidance is given in the relevant British Standards and Codes of Practice including BS5572[42], and the current Building Regulations[43]. Recommendations regarding spatial and access requirements for public health engineering services are given in Engineering Data Sheet EA5[44].

5.92 The gradient of branch drains should be uniform, and adequate to convey the maximum discharge to the stack without blockage. Practical considerations such as available angles of bends/junctions and their assembly, as well as space considerations, usually limit the minimum gradient to about 1:50 (20 mm/m). For the larger pipes, for example 100 mm diameter, flatter gradients can be used but require workmanship of a high standard if adequate self-cleansing flow is to be maintained. It is not envisaged that pipes larger than 100 mm diameter will be required within the drainage system serving this department.

5.93 In a radiology department particular attention should be given to the design and accessibility of traps and flushing apparatus to permit cleaning of barium and film emulsion residues from the drainage system. Accessibility for drain rodding is also important in these circumstances, but the system should be designed to avoid the necessity for internal manholes.

Operational considerations

5.94 Unusual and difficult maintenance problems can arise because of user interference and abuse. For example, the disposal of paper towels into WCs after hand-washing or after their misuse for some other purpose, is a frequent cause of blockages particularly in long branches laid to flat gradients. Adequate provision of disposal receptacles or where appropriate the installation of warm-air dryers can help to mitigate this problem.

Materials specification

5.95 The materials specified for the drainage system in this accommodation will depend upon their location and the nature of effluent being discharged. Waste pipework should, as far as practicable, be concealed; where exposed, it should be metallic and very securely fixed. Although adequate for the drainage requirements, uPVC may not always be acceptable to the fire officer and it should not be installed above "sensitive" areas, for example switchrooms, operating, intensive therapy or catering departments.

Chemical and radioactive contaminated effluent

5.96 Providing that there is adequate dilution and the silver content has been effectively recovered (see paragraph 3.86), the effluent can be discharged into the internal drainage system. Project teams are advised to establish the acceptable levels for silver and other processing chemicals at the planning stage of a scheme, as these are subject to change.

5.97 The drain from the toilet and shower associated with the diagnostic room where nuclear medicine imaging is undertaken will carry slightly radioactive effluent. It must be sealed throughout its run to the main sewer and its route chosen with regard to the areas likely to be affected if leaks develop. For further guidance see Engineering Data Sheets NZ1.1 and 1.11[45]. It is recommended that drainage for this purpose should not be into a pumped system.

5.98 At an appropriate early stage in the design process, the drainage system designer should discuss and verify with the local authority the project proposals for the collection and discharge of chemical and radioactive contaminated effluents. Some local authorities may impose restrictions on the quantity and rate of discharge of such effluents into public sewers.

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6.0 Cost information

Introduction

6.1 For all types of health buildings it is important that building costs and revenue expenditure are kept as low as possible consistent with acceptable standards. Within this general context, Building Notes provide a synopsis of accommodation for health buildings which the Department of Health, in conjunction with the National Health Service, recommends for the provision of a given service.

Works cost

6.2 To prepare an estimate of the works cost, reference should be made to the Capricode Health Building Procedures Manual (Chapter 1, Stage 1, Annex 1.c.). The total cost allowance is derived by aggregating the cost of the functional units, the Essential Complementary Accommodation (ECA) and the Optional Accommodation and Services (OAS) as appropriate.

6.3 The cost allowances cover the building and engineering requirements set out in this Note. In costing the radiology department it has been assumed that it will be incorporated into a district general hospital where the common use of services will be available.

Functional unit

6.4 The functional unit for this Note is the diagnostic room. Nine sizes of department have been costed, accommodating from four to 12 diagnostic rooms.

6.5 In addition there are separate suites of accommodation for ultrasound, computed tomography and nuclear medicine imaging.

6.6 The activity spaces and areas used for costing are listed in the schedules of accommodation at the end of this chapter.

6.7 The cost allowances include support steelwork for overhead equipment together with a suspended ceiling (see paragraph 3.35) and a floor with increased thickness of screed (see paragaph 3.41 and Option 1 of Appendix 5) in each diagnostic room.

Essential Complementary Accommodation

6.8 This comprises activity spaces which are essential to the running of the radiology department but which in certain circumstances may be available in a convenient location elsewhere. The Essential Complementary Accommodation costed in this Note is listed in the schedules of accommodation at the end of this chapter.

Optional Accommodation and Services

6.9 This Note, where appropriate, draws attention to alternative ways of providing services or facilities, including the likely cost implications. This information will enable project teams to select the solution which is most suitable to their needs. The Optional Accommodation and Services costed in this Note is listed in the schedules of accommodation at the end of this chapter.

6.10 The following options discussed in this Note have not been costed:

a. pass-through changing cubicles (see paragraph 3.13);

b. manual processing (see paragraph 3.76);

c. centralised chemical supply (see paragraph 3.85);

d. centralised silver recovery (Appendix 8);

e. lightweight modular access floor (Option 2 of Appendix 5);

f. load-bearing modular access floor (Option 3 of Appendix 5).

Dimensions and areas

6.11 In determining spatial requirements, the essential factor is not the total area provided but the critical dimensions, that is, those dimensions critical to the efficient functioning of the activities which are to be carried out. To assist project teams in preparing detailed design solutions for the rooms and spaces, studies have been carried out to establish dimensional requirements in the form of critical dimensions. The results of these studies appear as ergonomic diagrams in Appendix 1 of this Note and in HBN 40 – 'Common activity spaces'.

6.12 For development planning and at the earliest stage of a design it may be convenient for designers to have data available which will enable them to make an approximate

assessment of the sizes involved. For this reason the areas prepared for the purpose of establishing the cost allowances are included at the end of this chapter.

6.13 It is emphasised that the areas published **do not** represent recommended sizes, nor are they to be regarded in any way as specific individual entitlements.

Circulation

6.14 Space for circulation, which includes allowances for planning provision, an engineering zone adjacent to the external walls, small vertical ducts and partitions, is shown in the shedules of accommodation and is included in the cost allowances.

Communications

6.15 Staircases, lifts and plant rooms, with the exception of an electrical switchroom and a standard enclosure for medical gas isolation points, are not included in the cost allowances.

Engineering services

6.16 The following engineering services as described in Chapter 5, and exemplified in the Activity Data, are included in the cost allowances. Primary engineering services are assumed to be conveniently available at the boundary of the department.

a. Mechanical services:

(i) heating: low pressure hot water system;

(ii) ventilation: mechanical supply and extract to meet clinical and functional requirements – other areas will be mainly naturally ventilated;

(iii) optional provision of air cooling in some diagnostic rooms;

(iv) cold water service: centrally supplied to service points including drinking water and fire hose reels. Storage tanks excluded;

(v) hot water service: centrally supplied to service points. Storage excluded;

(vi) medical gas: piped supply of oxygen, nitrous oxide and vacuum from the hospital centralised system. Waste gas scavenging system in each special procedures diagnostic room;

b. Electrical services:

(i) departmental distribution switchboard;

(ii) general lighting as required by tasks;

(iii) fluorescent, tungsten, safety and emergency luminaires as appropriate;

(iv) socket outlets and other power outlets for fixed and portable equipment;

(v) supplementary equipotential earth bonding connections;

(vi) standby and safety installation from the main hospital supplies;

(vii) intercommunication system;

(viii) patient/staff call system;

(ix) staff location – extension to the hospital system;

(x) telephone internal cabling distribution and outlets. Handsets excluded;

(xi) data transmission trunking and conduits only;

(xii) fire, medical gas and drug cupboard alarm systems;

(xiii) impulse clocks;

c. Equipment (Group 1):

water boilers, bedpan liner disposal units or bedpan washers with integral steam generator.

Schedules of accommodation

Para no	Activity space	Space area sq m	4 R/D rooms Qty	4 R/D rooms Total area sq m	5 R/D rooms Qty	5 R/D rooms Total area sq m	6 R/D rooms Qty	6 R/D rooms Total area sq m	7 R/D rooms Qty	7 R/D rooms Total area sq m	8 R/D rooms Qty	8 R/D rooms Total area sq m	9 R/D rooms Qty	9 R/D rooms Total area sq m	10 R/D rooms Qty	10 R/D rooms Total area sq m	11 R/D rooms Qty	11 R/D rooms Total area sq m	12 R/D rooms Qty	12 R/D rooms Total area sq m
3.3	Reception/appointment area		1.0	29.00	1.0	31.00	1.0	33.50	1.0	35.50	1.0	38.00	1.0	43.00	1.0	49.50	1.0	54.50	1.0	61.00
3.7	Master index/report index/diagnostic index																			
3.4	Patients' main waiting area		1.0	21.00	1.0	23.50	1.0	27.50	1.0	30.00	1.0	34.00	1.0	36.50	1.0	39.50	1.0	42.00	1.0	45.00
3.5	Bed/trolley/wheelchair waiting area		1.0	7.00	1.0	7.00	1.0	7.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	13.00	1.0	13.00
3.6	Porters' base		1.0	2.00	1.0	2.00	1.0	3.00	1.0	3.00	1.0	3.00	1.0	4.00	1.0	4.00	1.0	4.00	1.0	4.00
3.8	Patients sub-waiting	11.00	1.0	11.00	2.0	11.00	2.0	22.00	3.0	33.00	3.0	33.00	4.0	44.00	4.0	44.00	5.0	55.00	5.0	55.00
3.9	Ditto for Accident and Emergency	15.00	1.0	15.00	1.0	15.00	1.0	15.00	1.0	15.00	1.0	15.00	1.0	15.00	1.0	15.00	1.0	15.00	1.0	15.00
3.11	Changing cubicle – ambulant patient	1.50	9.0	13.50	11.0	16.50	13.0	19.50	16.0	24.00	18.0	27.00	21.0	31.50	23.0	34.50	25.0	37.50	27.0	40.50
3.11	Changing cubicle – assisted patient	3.50	2.0	7.00	3.0	10.50	3.0	10.50	3.0	10.50	4.0	14.00	4.0	14.00	5.0	17.50	5.0	17.50	6.0	21.00
3.14	Ambulant patients' WC	2.00	2.0	4.00	3.0	6.00	4.0	8.00	4.0	8.00	5.0	10.00	5.0	10.00	6.0	12.00	6.0	12.00	7.0	14.00
3.14	Wheelchair patients' WC	4.00	1.0	4.00	1.0	4.00	1.0	4.00	1.0	4.00	1.0	4.00	2.0	8.00	2.0	8.00	2.0	8.00	2.0	8.00
3.15	Barium enema WC	4.00	2.0	8.00	2.0	8.00	2.0	8.00	2.0	8.00	2.0	8.00	2.0	8.00	2.0	8.00	2.0	8.00	2.0	8.00
3.20	General purpose diagnostic room	33.00	2.0	66.00	3.0	99.00	3.0	99.00	4.0	132.00	4.0	132.00	5.0	165.00	5.0	165.00	6.0	198.00	6.0	198.00
3.22	Specialised diagnostic room	38.00	2.0	76.00	2.0	76.00	3.0	114.00	3.0	114.00	4.0	152.00	4.0	152.00	5.0	190.00	5.0	190.00	6.0	228.00
3.24	Scrub-up	6.00	1.0	6.00	1.0	6.00	1.0	6.00	1.0	6.00	1.0	6.00	1.0	6.00	1.0	6.00	1.0	6.00	1.0	6.00
3.52	Sorting and collating area																			
3.55	Film dispatch and return		1.0	62.00	1.0	70.50	1.0	79.00	1.0	87.50	1.0	96.00	1.0	100.00	1.0	108.00	1.0	114.00	1.0	120.00
3.87	Current image storage																			
3.64	Nurse base																			
3.65	Holding and recovery area		1.0	26.00	1.0	26.00	1.0	26.00	1.0	26.00	1.0	26.00	1.0	36.00	1.0	36.00	1.0	36.00	1.0	36.00
3.67	Clean utility																			
3.69	Dirty utility	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	11.50
3.66	Resuscitation trolley bay	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50
3.72	Disposal hold	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50	1.0	2.50
3.77	Daylight automatic processing, viewing,																			
3.47	checking and preliminary reporting area	21.00	1.0	21.00	2.0	42.00	2.0	42.00	3.0	63.00	3.0	63.00	4.0	84.00	3.0	63.00	4.0	84.00	4.0	84.00
3.81	Ditto with darkroom	25.00	1.0	25.00	1.0	25.00	1.0	25.00	1.0	25.00	1.0	25.00	1.0	25.00	2.0	50.00	2.0	50.00	2.0	50.00
3.95	Radiologists' office	12.00	1.0	12.00	1.0	12.00	2.0	24.00	3.0	36.00	3.0	36.00	4.0	48.00	4.0	48.00	5.0	60.00	5.0	60.00
3.58	Ditto/clinical conference	19.00	1.0	19.00	1.0	19.00		–		–		–		–		–		–		–
	carried forward			448.50		535.00		587.00		684.50		746.00		854.00		922.00		1018.50		1083.00

Para no	Activity space	Space area sq m	4 R/D rooms Qty	4 R/D rooms Total area sq m	5 R/D rooms Qty	5 R/D rooms Total area sq m	6 R/D rooms Qty	6 R/D rooms Total area sq m	7 R/D rooms Qty	7 R/D rooms Total area sq m	8 R/D rooms Qty	8 R/D rooms Total area sq m	9 R/D rooms Qty	9 R/D rooms Total area sq m	10 R/D rooms Qty	10 R/D rooms Total area sq m	11 R/D rooms Qty	11 R/D rooms Total area sq m	12 R/D rooms Qty	12 R/D rooms Total area sq m
	brought forward			448.50		535.00		587.00		684.50		746.00		854.00		922.00		1018.50		1083.00
3.57	Central reporting/clinical conference			–		–	1.0	21.00	1.0	21.00	1.0	30.00	1.0	30.00	1.0	39.00	1.0	39.00	1.0	39.00
3.98	Superintendent radiographers' office	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00
3.100	Business manager's office	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00	1.0	10.00
3.101	Secretarial office	9.00		–		–	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00	1.0	9.00
3.101	Secretaries/typists		1.0	16.00	1.0	16.00	1.0	9.00	1.0	15.00	1.0	15.00	1.0	21.00	1.0	21.00	1.0	27.00	1.0	27.00
3.102	Staff room		1.0	18.00	1.0	19.50	1.0	21.00	1.0	22.50	1.0	24.00	1.0	27.00	1.0	30.00	1.0	33.00	1.0	36.00
3.103	Male staff changing		1.0	2.00	1.0	2.00	1.0	2.50	1.0	2.50	1.0	3.00	1.0	3.50	1.0	4.00	1.0	4.50	1.0	5.00
3.103	Female staff changing		1.0	7.00	1.0	7.50	1.0	8.00	1.0	8.50	1.0	9.00	1.0	10.00	1.0	11.00	1.0	12.00	1.0	13.00
3.106	Staff WC	2.00	2.0	4.00	2.0	4.00	2.0	4.00	2.0	4.00	2.0	4.00	3.0	6.00	3.0	6.00	4.0	8.00	4.0	8.00
3.107	Shower	3.50	1.0	3.50	1.0	3.50	1.0	3.50	1.0	3.50	1.0	3.50	1.0	3.50	1.0	3.50	1.0	3.50	1.0	3.50
3.108	Barium preparation area	8.00	1.0	8.00	1.0	8.00	1.0	8.00	1.0	8.00	1.0	8.00	1.0	8.00	1.0	8.00	1.0	8.00	1.0	8.00
3.109	Cleaners' room	7.00	1.0	7.00	1.0	7.00	1.0	7.00	1.0	7.00	1.0	7.00	1.0	7.00	1.0	7.00	1.0	7.00	1.0	7.00
3.110	General store		1.0	8.00	1.0	8.50	1.0	9.00	1.0	9.50	1.0	10.00	1.0	11.00	1.0	12.50	1.0	13.50	1.0	15.00
3.111	Unused film store		1.0	4.00	1.0	4.50	1.0	5.00	1.0	5.50	1.0	6.00	1.0	6.50	1.0	6.50	1.0	7.00	1.0	7.00
3.112	Chemical store		1.0	3.00	1.0	3.50	1.0	4.00	1.0	4.50	1.0	5.00	1.0	6.50	1.0	6.50	1.0	7.50	1.0	8.00
3.113	Linen store		1.0	4.00	1.0	4.50	1.0	5.00	1.0	5.50	1.0	6.50	1.0	7.00	1.0	7.50	1.0	7.50	1.0	8.00
3.114	Mobile X-ray equipment parking bay		1.0	4.50	1.0	4.50	1.0	4.50	1.0	4.50	1.0	4.50	1.0	6.00	1.0	6.00	1.0	6.00	1.0	6.00
3.115	Workshop	11.00	1.0	11.00	1.0	11.00	1.0	11.00	1.0	11.00	1.0	11.00	1.0	11.00	1.0	11.00	1.0	11.00	1.0	11.00
3.116	Switchroom		1.0	4.00	1.0	4.50	1.0	5.00	1.0	5.50	1.0	6.00	1.0	6.50	1.0	7.50	1.0	8.50	1.0	9.00
	Nett total			572.50		663.50		743.50		851.50		927.50		1053.50		1138.00		1250.50		1322.50
	Circulation etc			206.00		238.50		267.50		306.50		333.50		379.00		409.50		450.00		476.00
	Totals			778.50		902.00		1011.00		1158.00		1261.00		1432.50		1547.50		1700.50		1798.50
	Departmental areas		780 sq m		900 sq m		1010 sq m		1160 sq m		1260 sq m		1435 sq m		1550 sq m		1700 sq m		1800 sq m	

Ultrasound suite

Para no	Activity space	Space area sq m	Qty	Total area sq m
3.25	Examination room	21.50	1.0	21.50
3.8	Sub-waiting area	4.50	1.0	4.50
3.11	Changing cubicle – assisted patient	3.50	1.0	3.50
3.16	Patients' WC	2.00	1.0	2.00
	Nett total			31.50
	Circulation etc			11.50
	Total			43.00
	Departmental area			45 sq m

Computed Tomography suite

Para no	Activity space	Space area sq m	Qty	Total area sq m
3.26	Scanner room	38.00	1.0	38.00
3.27	Computer and electrical equipment area	8.00	1.0	8.00
3.28a	Control room	20.00	1.0	20.00
3.29	Laser imaging area	8.00	1.0	8.00
3.28b	Office/reporting	15.00	1.0	15.00
3.28	Sub-waiting area	4.50	1.0	4.50
3.28	Changing cubicle – ambulant patient	1.50	1.0	1.50
3.28	Changing cubicle – assisted patient	3.50	1.0	3.50
3.28	Patients' WC	2.00	1.0	2.00
3.30	Store room	8.00	1.0	8.00
	Nett total			108.50
	Circulation etc			39.00
	Total			147.50
	Departmental area			150 sq m

Nuclear Medicine Imaging suite

Para no	Activity space	Space area sq m	Qty	Total area sq m
3.31	Gamma camera room	33.00	1.0	33.00
3.11	Changing cubicle – ambulant patient	1.50	1.0	1.50
3.11	Changing cubicle – assisted patient	3.50	1.0	3.50
3.31a	Isotope store and injection room	24.00	1.0	24.00
3.31b	Wheelchair patients' WC	4.00	1.0	4.00
3.31b	Assisted shower	5.00	1.0	5.00
3.31c	Post-injection waiting area	28.00	1.0	28.00
3.31d	Disposal hold	4.50	1.0	4.50
3.32	Office/reporting	15.00	1.0	15.00
	Nett total			118.50
	Circulation etc			42.50
	Total			161.00
	Departmental area			160 sq m

Essential Complementary Accommodation

Para no	Activity space	Space area sq m	Circ'n etc sq m	Total area sq m
3.117	Seminar room	36.00	13.00	49.00
3.118	Counselling room	9.00	3.00	12.00

Optional Accommodation and Services

Para no	Activity space	Space area sq m	Circ'n etc sq m	Total area sq m
3.63	Nurse's office	10.00	3.50	13.50
3.83	Additional darkroom	5.50	2.00	7.50
3.95	Radiologist's office	12.00	4.50	16.50
3.101	Typist's room	7.50	2.50	10.00
3.120	Special procedures changing room	6.50	2.50	9.00
3.121	Anaesthetic room	14.50	5.00	19.50
3.122	Lavage room – trolley	12.00	4.50	16.50
5.33	Cooling to diagnostic room	No additional area required		
5.35	Humidity control to film processing area	No additional area required		

7.0 Activity Data

7.1 "Activity Data" is an information system developed to help project and design teams by defining the users' needs more precisely. This information constitutes the computerised Activity DataBase, first issued to Health Authorities in England and to the Health Departments in Scotland, Northern Ireland and Wales in 1989, and subsequently updated twice yearly. It comprises three types of information sheet: Activity Space Data Sheets (known as A-Sheets), their supporting Activity Unit Data Sheets (known as B-Sheets) and A-Sheet component listings (known as D-Sheets).

7.2 A-Sheets record in more detail than is described in this Note each task or activity that is performed in a particular activity space (which may be a room, space, corridor or bay) together with environmental conditions and the technical data necessary to enable the activities to be performed. Each A-Sheet also contains a list of the titles and code numbers of the relevant B-Sheets.

7.3 B-Sheets provide narrative text, and graphics to scale, relating to one activity. They show equipment fitted or supplied as part of the building, and the necessary engineering terminals. There are also "component B-Sheets" which show a range of particular components rather than an activity.

7.4 D-Sheets provide information about the total quantities of components (excluding those in Group 4 – see paragraph 1.17) extracted from all B-Sheets selected for inclusion in an individual A-Sheet.

7.5 Activity Data is only available in the form of magnetic media, but this may be used to generate paper copies where required.

7.6 Further information about the use and preparation of Activity Data can be found in the 'Guide to "A" and "B" Activity Data Sheets and their use in Health Building Schemes', issued to Health Authorities with EL(89)MB/19 (in Wales, WHC(89)18). Health Authorities may obtain additional copies of the Guide and an explanatory videotape from NHS Estates, Room 540, Euston Tower, 286 Euston Road, London NW1 3DN.

Activity Data applicable to this Note

7.7 The A-Sheets recommended for the activity spaces described in this Note are either new sheets, amended ones or selected from existing sheets. A-Sheet code numbers are given at the end of this chapter.

7.8 Further Activity Data Sheets may be selected, or drawn up by project teams to their own requirements, for any services not described in the Note or included in the list. Members of project teams are advised to contact their Activity Data Co-ordinator/Welsh Office for information and advice about the selection of activity data, at an early planning stage.

7.9 In order to ensure consistent and economic provision, variations from the A-Sheets recommended for the spaces covered in this Note should be considered only where it has been decided that the function of a space will differ substantially from that described.

7.10 **Note:** the Activity Data A-Sheets listed overleaf may not carry a title identical to the activity spaces detailed in this Note. Use of the appropriate A-Sheet code number will, however, result in the correct activity space being accessed.

Activity space	A-Sheet code no	Para no in HBN	Activity space	A-Sheet code no	Para no in HBN
Counselling room	D1701	3.118	Office: business manager	M0234	3.100
Staff room, with overnight stay	D0204	3.102	Office medical: radiologist	M0309	3.95
			Office medical	M0311	3.95
Ultrasound rooms	E0113	3.25	Office medical	M0312	3.95
Darkroom	E0201	3.81	Office medical: admin	M0313	3.95
Fluoroscopy room	E0502	3.18	Office: NM viewing	M0415	3.32
Urography room	E0503	3.18	Office: superintendent	M0508	3.98
Anaesthesia bay	E0506	3.121	Office: secretarial	M1027	3.101
Central reporting	E0509	3.57	Office: secretarial admin	M1316	3.101
Central reporting	E0510	3.57	Porters' base	M1706	3.6
Film dispatch	E0511	3.55			
Sorting and collating room	E0513	3.52	NM darkroom	R0105	3.83
Records: film store	E0515	3.52			
Radiodiagnostic room	E0516	3.20	Staff base: nurse	T0109	3.64
Daylight processing	E0517	3.77	Staff base: nurse: holding and recovery	T0118	3.65
Darkroom	E0521	3.81	Clean utility	T0510	3.67
Special procedures room	E0522	3.22			
CT scanner room	E0601	3.26	Staff change: WC/wash	V0301	3.103
CT plant room	E0602	3.27	Staff change: 5	V0510	3.103
CT computer space	E0603	3.27	Staff change: 20	V0512	3.103
CT control room	E0604	3.28	Staff change: special procedures	V0509	3.120
CT office/reporting	E0605	3.28	WC: patient: wheelchair	V0904	3.14
CT laser imaging	E0606	3.29	WC/wash	V0907	3.14
NM "hot waiting room"	E0701	3.31a	Staff wash/WC	V1007	3.106
NM WC/wash, wheelchair	E0705	3.31b	WC/wash: ultrasound	V1104	3.16
NM assisted shower	E0708	3.31b	WC/wash: with calls	V1106	3.14
NM injection room	E0710	3.31a	WC/wash: barium enema	V1219	3.15
NM gamma camera room	E0712	3.31	Shower: patient	V1606	3.107
			Scrub-up and gowning	V2508	3.24
Equipment – parking	G0101	3.114			
Resuscitation trolley	G0104	3.66	Linen store	W0301	3.113
Patient trolley, pkg	G0202	3.5	Store: unused films	W0303	3.111
			Store: current films	W0308	3.87
Seminar room	H0102	3.117	Store: general	W0310	3.110
			Store: chemicals	W0311	3.112
Reception	J0608	3.3			
Main waiting	J1104	3.4	Lavage room	X0505	3.122
Sub-waiting: cubicles 6	J1209	3.11	Barium preparation area	X0507	3.108
Sub-waiting: ultrasound	J1214	3.10			
Sub-waiting: cubicles 9	J1215	3.11	NM: dirty utility	Y0315	3.32
Sub-waiting: A and E patients	J1219	3.9	Dirty utility	Y0413	3.69
			Disposal hold: isotope waste	Y0602	3.31d
Switchgear	K0101	3.116	Disposal hold: general	Y0603	3.72
Workshop	K0303	3.115	Cleaners' space	Y1501	3.109

Appendix 1

Critical dimensions

Introduction

1. Critical dimensions are those dimensions which are critical to the efficient functioning of an activity; thus the size of components, their position and the space around them may all be critical to the task being performed. Guidance on these dimensions for a particular activity is provided in the form of component-user data sheets. These illustrate components, that is, equipment, furniture and fittings, and provide ergonomic data on the space required for users to move, operate or otherwise use the component; information about the component, for example fixing heights, and the users, for example reach, is also provided. Component-user data sheets thus complement the information given on Activity Data B-Sheets (see Chapter 7).

2. This appendix contains sheets relevant to this Note. In addition, ergonomic data common to the design of a number of departments is contained in HBN 40 – 'Common activity spaces', to which reference should also be made.

Component dimensions

3. These relate to the size and position of components as follows:

a. sizes of components are shown thus:

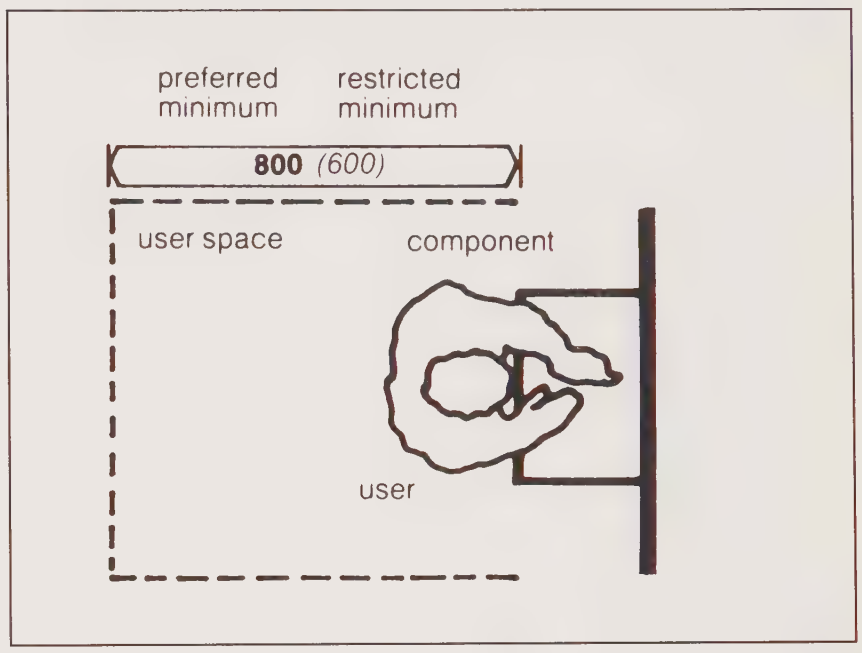
b. preferred component fixing heights are shown as heights above floor level thus:

1000
1000-1300

(In some cases an acceptable range of fixing heights is also given in italics.)

Activity dimensions

4. Activity dimensions define the user space, which is the minimum space required to perform an activity. Two types of activity dimension are given:

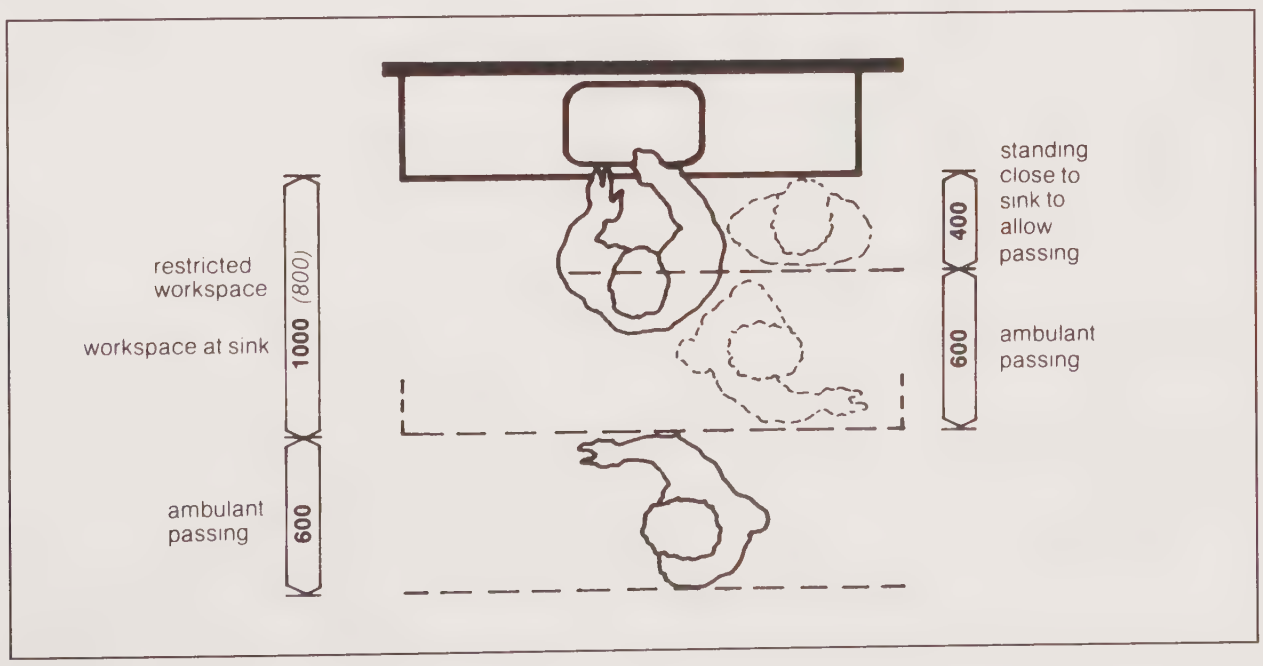


a. preferred minimum – this defines the minimum space required to carry out an activity efficiently and is shown in bold type;

b. restricted minimum – this will only allow the activity to be performed at the expense of the user experiencing some difficulty. It is not recommended for general application but may be appropriate when considering the overlapping that can be allowed when two user spaces are adjoining.

Selection of activity dimensions

5. When using component-user data sheets to design activity space layouts, selection of the appropriate activity dimensions is essential for economy and efficiency. Selection should be based on careful consideration of the frequency, duration, timing and importance of the activities

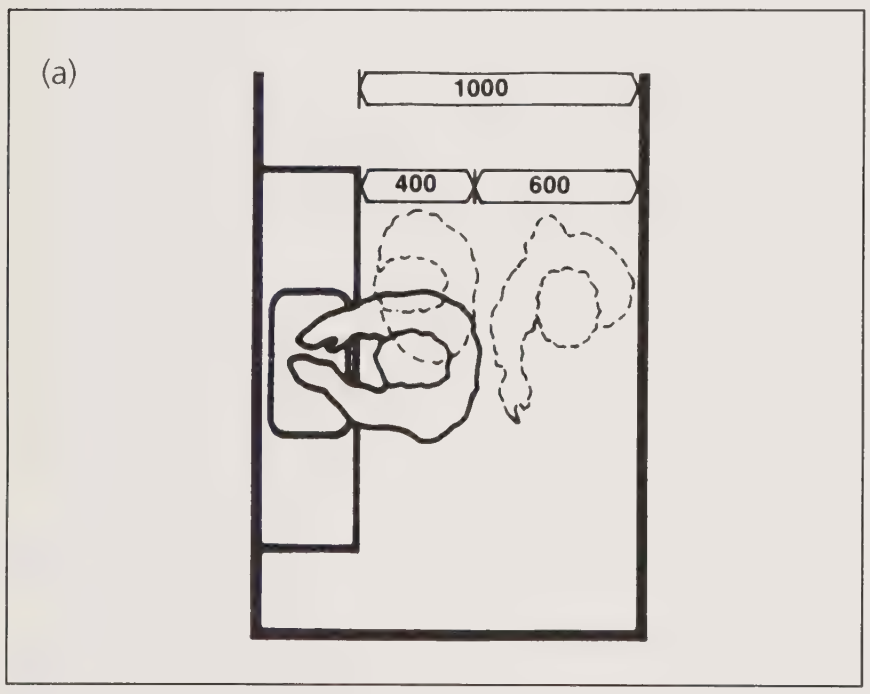


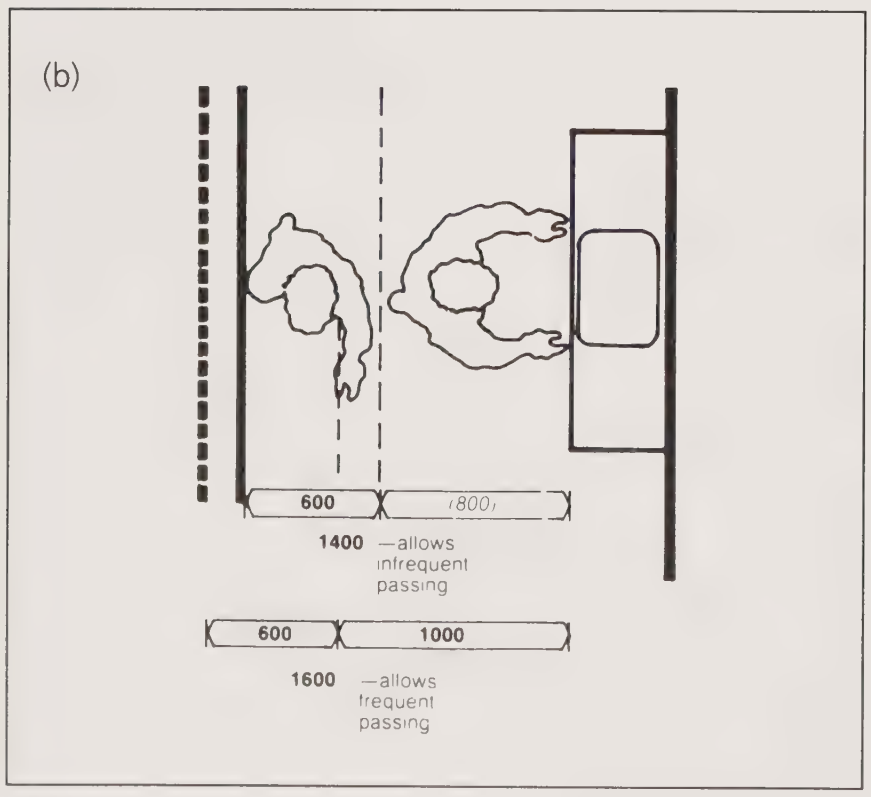
and also the number of people involved. A typical example of the use of a sink showing activity dimensions provided by the component-user data sheet is shown on the previous page.

Examples

6. The following worked examples show the sink being used in three different situations and show how the appropriate dimensions would be selected. These examples have been simplified and additional factors such as the movement of mobile equipment may also be critical. The examples do not necessarily relate to this particular building guidance.

a. If the room is normally occupied by one person only, the 1000 workspace dimension may be applicable. A restricted (800) dimension should not be used, as this dimension is only applicable where two user spaces are adjoining, not where an individual user space is bounded by a wall or solid obstruction. If the person using the sink stops work and stands close to the sink, 1000 is also sufficient space to allow a second person to pass, that is, 600 + 400.

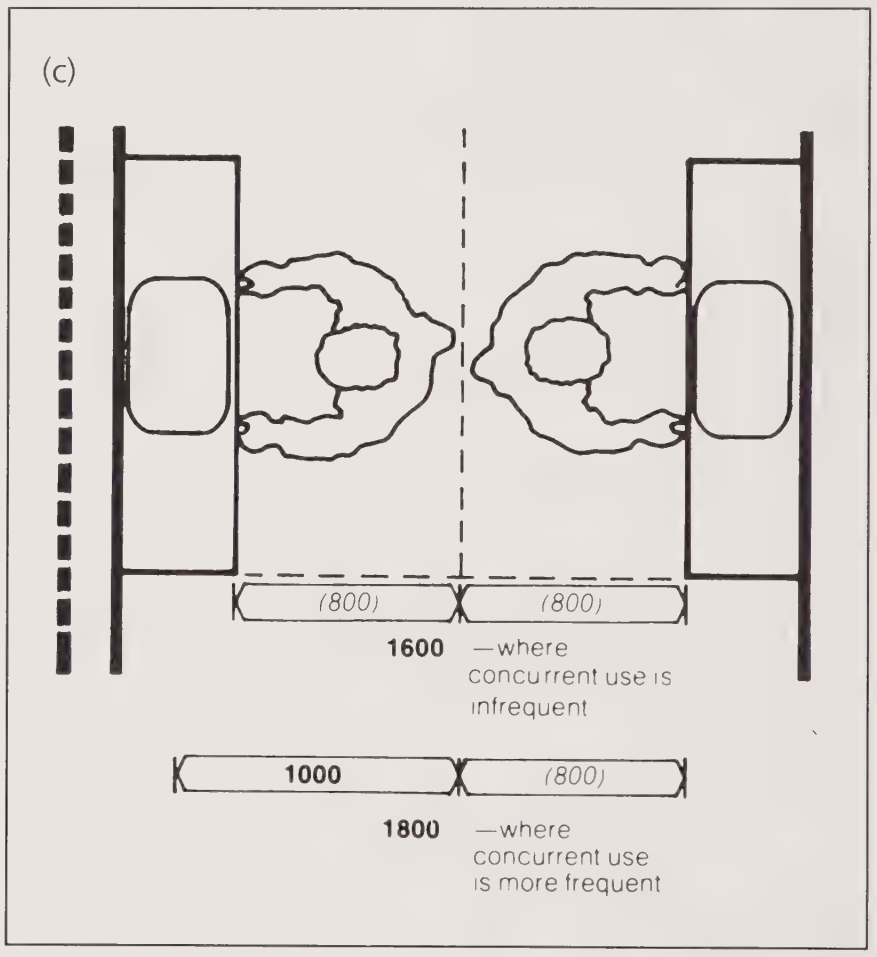




b. If space is required to allow a person to pass without the user of the sink stopping work, then the 600 passing dimension is added to the workspace dimension. If passing is infrequent then temporary restriction of the sink user's space may be acceptable; this gives an overall dimension of 600 + (800) = 1400. If passing is frequent and restriction of the sink user's space is not acceptable the overall dimension is 600 + 1000 = 1600.

c. Where space has to be provided to enable two sinks to be used concurrently the overall dimension between sinks will be the sum of the workspace dimensions, for example if concurrent use is infrequent and of short duration then (800) + (800) = 1600 may be acceptable. Alternatively 1000 + (800) = 1800 allows the full workspace for one sink user and restricted space for the second user, where concurrent use of the sinks is more frequent.

Note: the passing of a third person between the two sink users may also be critical in this example. Where the sinks are staggered 1400 may be acceptable as in example b.

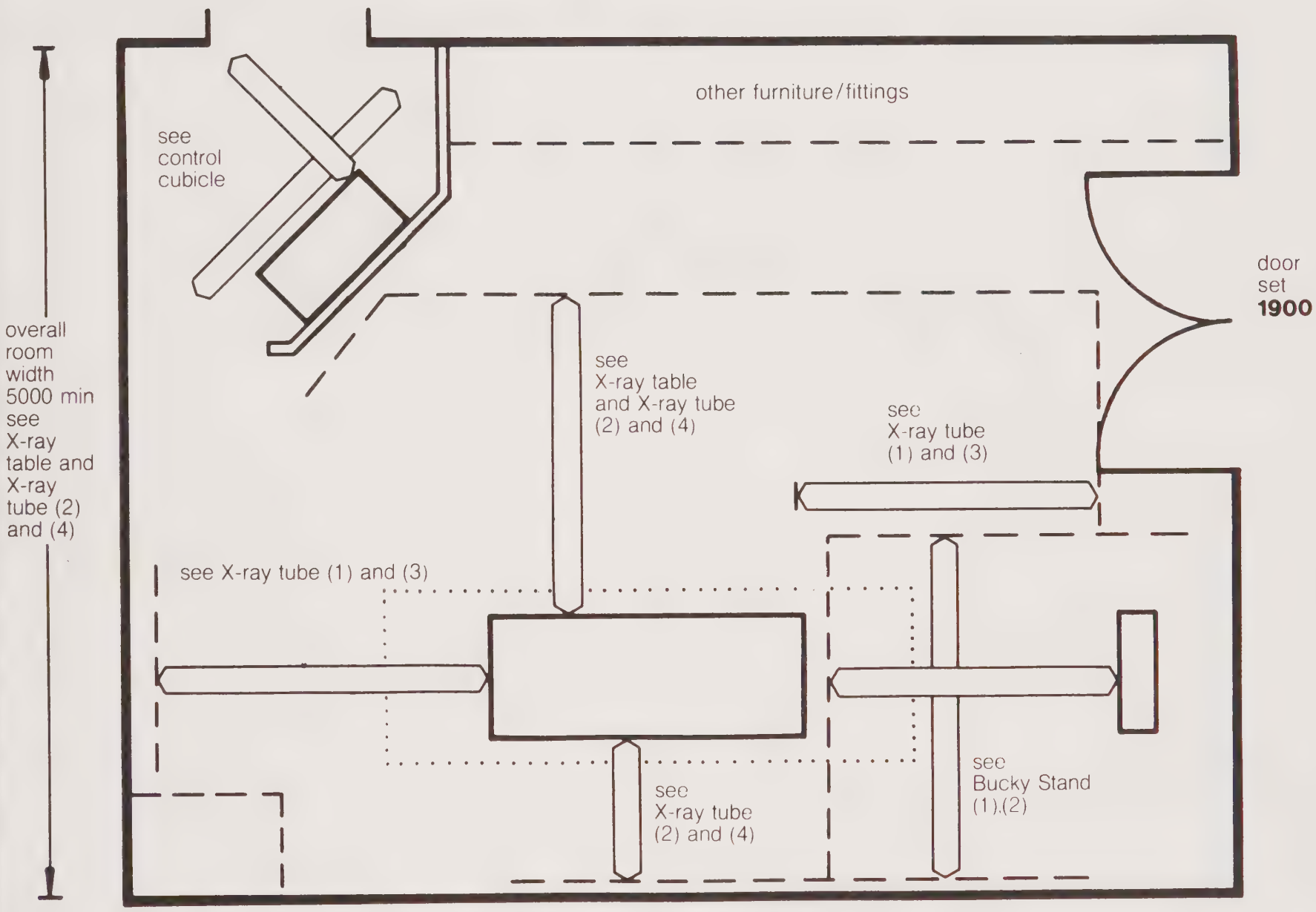


List of ergonomic drawings

1. Key diagram
2. Control cubicle
3. X-ray table
4. X-ray tube (1)
5. X-ray tube (2)
6. X-ray tube (3)
7. X-ray tube (4)
8. Bucky stand (1)
9. Bucky stand (2)
10. X-ray illuminators
11. X-ray worktop

Key Diagram

X-ray HBN



Notes:

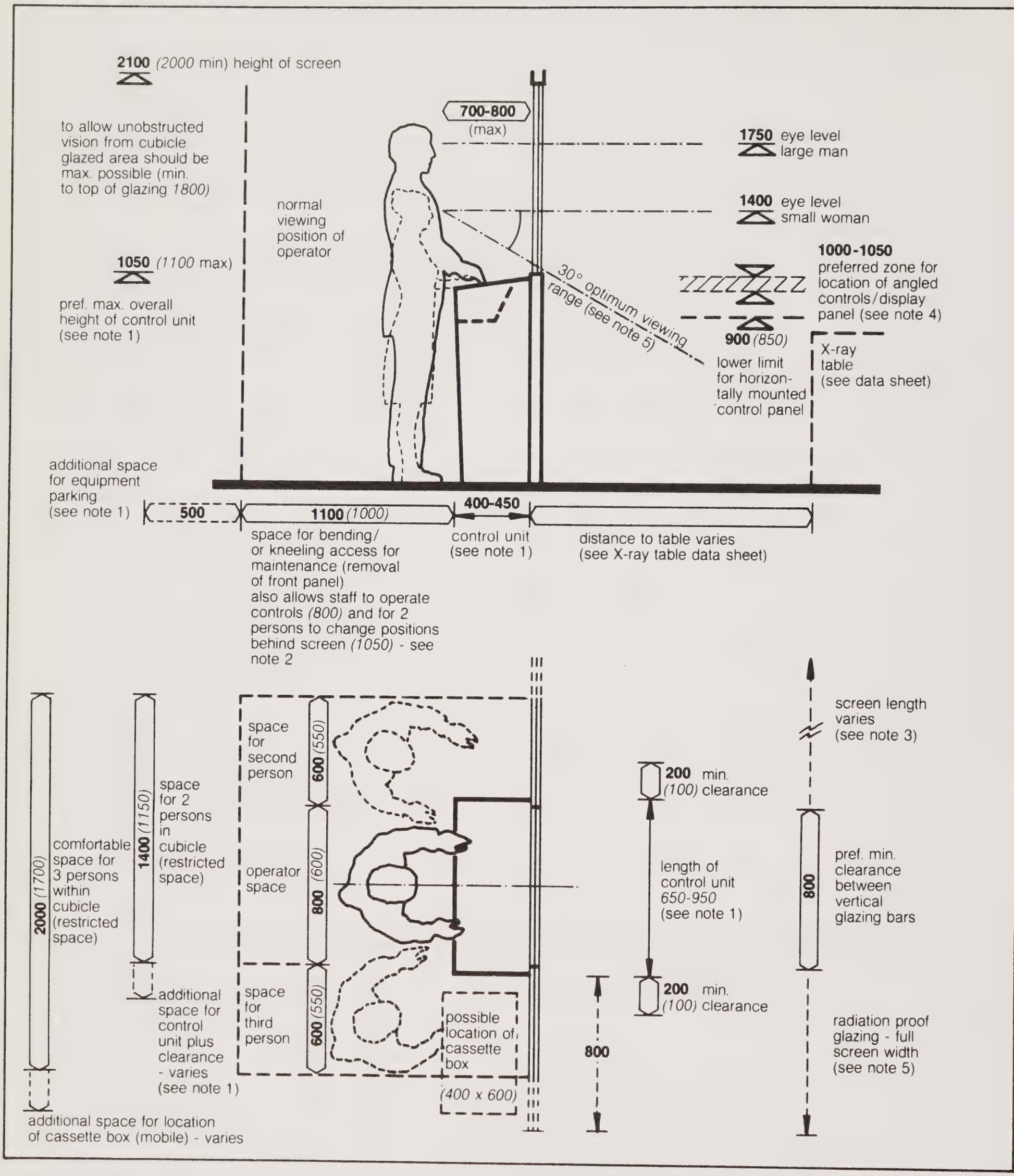
The ergonomic data sheets on X-ray equipment relate specifically to general purpose radiodiagnostic rooms and include X-ray tables, bucky stands and control console. In the layout of general purpose radiodiagnostic rooms the space requirements around these items of equipment are particularly critical. However consideration should also be given to other fittings and equipment such as worktop/storage units, washing facilities, small trolleys, protective apron racks, chairs and specialised or electronic equipment racks etc. Inclusion of any additional items of X-ray equipment (eg small dental unit) may also affect overall space requirements.

The schematic drawing above is intended to show a likely relationship between these main items of equipment within a general purpose radiodiagnostic room.

Activities:
Control of exposure factors during general radiodiagnostic procedures behind radiation proof screen.

Control cubicle

Users
Radiographer



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes)*

Notes:

1. Size of control unit varies. Unit shown is typical of modern designs where there is a tendency to reduce the size of console by housing more bulky elements elsewhere in the radiodiagnostic room in floor mounted electronic equipment cabinets. These cabinets are normally located in functionally unused areas within the radiodiagnostic room, rather than in the console operators cubicle where priority must be given to staff access and the location of other essential control and display equipment.

2. Passing will not occur during operation of the X-ray tube.

3. Length of protective screen 1600 preferred to accommodate 2 persons side by side 2000 for 3 persons.

4. Displays must be clearly and logically related to their appropriate controls and must not be obscured by operation of the controls. Preferred angle for control/display panel 30° (range 15 - 45). Width of controls should pref. not exceed 700.

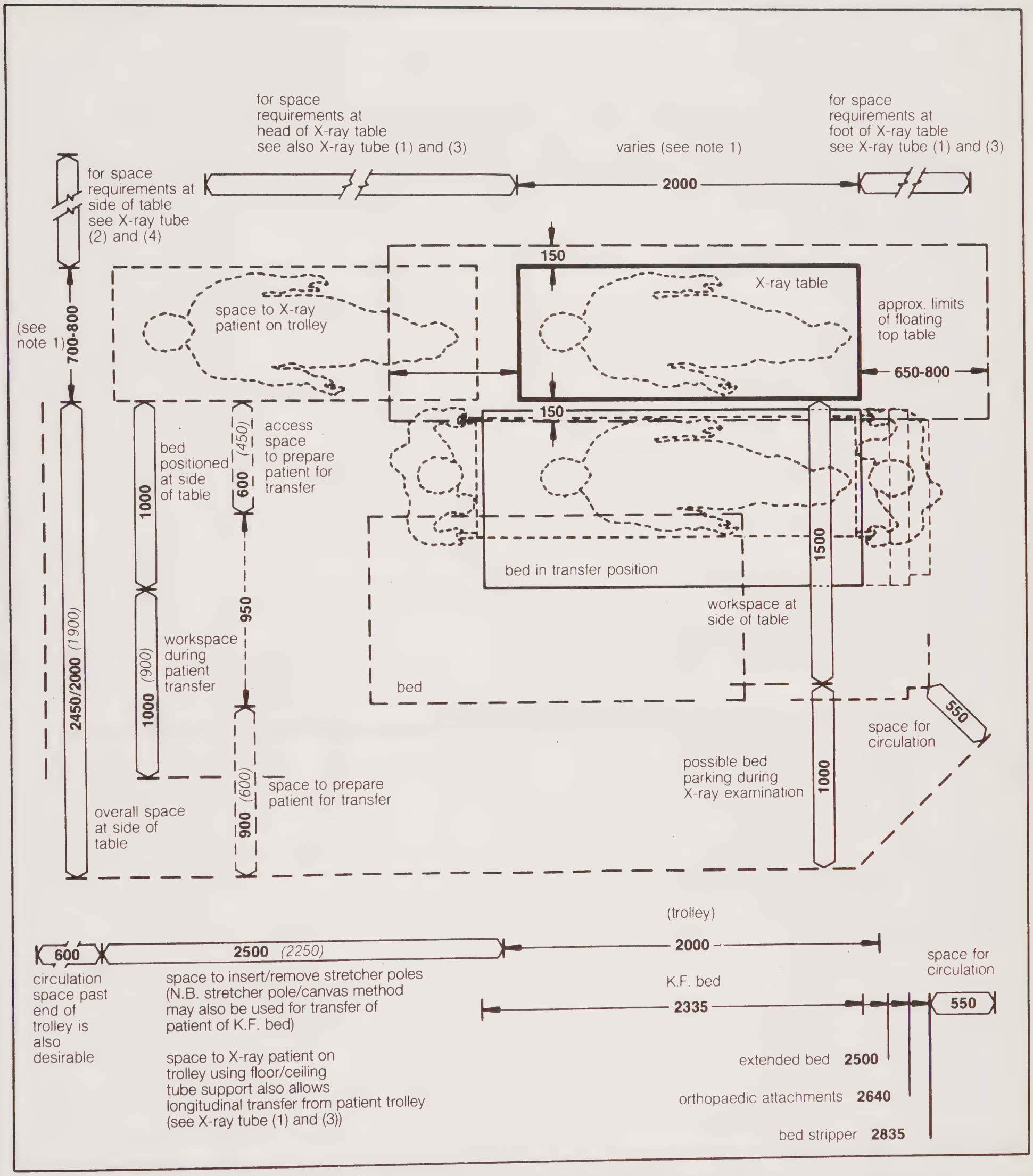
5. The radiation proof glazing should preferably be of full screen width to allow unimpeded view of the patient at all times.

Activities:
Transfer of patient from bed or trolley to X-ray table.

X-ray table

fixed/sliding/floating/top

Users:
Radiographer and patient.



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes)*

Notes:

1. X-ray table may be fixed, sliding, floating or tilting types - dimensions vary depending on type and manufacturer.

2. Patient transfer
Initially the patient may be positioned parallel to the table with sufficient space between table and trolley/bed to allow an attendant to prepare patient prior to transfer. Space should allow mechanical and other transfer aids to be employed whenever necessary to minimise possible back injury to staff. Commonly the patient is slid across on to and off the X-ray table. A removable transfer mat should be used. Another method is to use stretcher poles and canvas for lifting patient to and from the bed or trolley. In critical cases where manual handling of supine patient is essential, four or more persons lifting will be involved. Space to move clear of bed or trolley will be needed and the full width and length (larger dimension) recommendations are necessary to undertake this manoeuvre safely

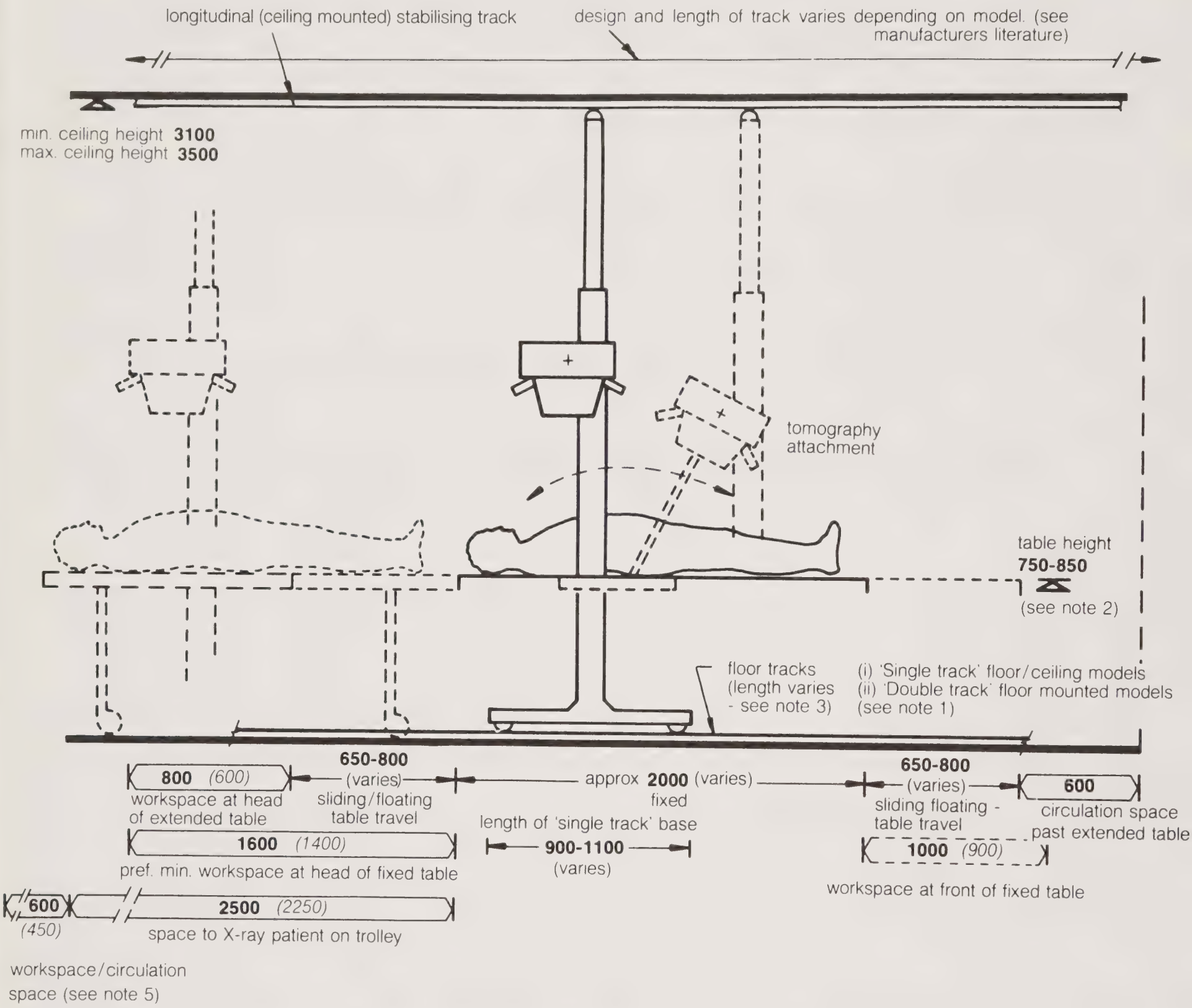
3. Operational experience indicates that overall room widths should preferably not be less than 5 metres

Activities:
General radiodiagnostic procedures

X-ray tube (1)

Floor/ceiling support
(with fixed or sliding or floating top table)

Users:
Radiographer and patient



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes).*

Notes:

1. Floor/ceiling columns are preferred to models which are floor mounted only. This is because they are more stable and present less obstruction to staff approach at floor level. (Ceiling mounted columns - see X-ray tube (3) and (4) - should however be employed whenever possible as they give all-round access to the patient and provide greater tube mobility, including lateral exposures from either side of the patient).

2. Table height and patient trolley height should be the same to assist patient transfer.

3. Both floor and ceiling track lengths vary depending on model, manufacturer and type of X-ray table used but are usually both between 4000-5500 long.

4. See also X-ray tube (2) and X-ray table data sheet.

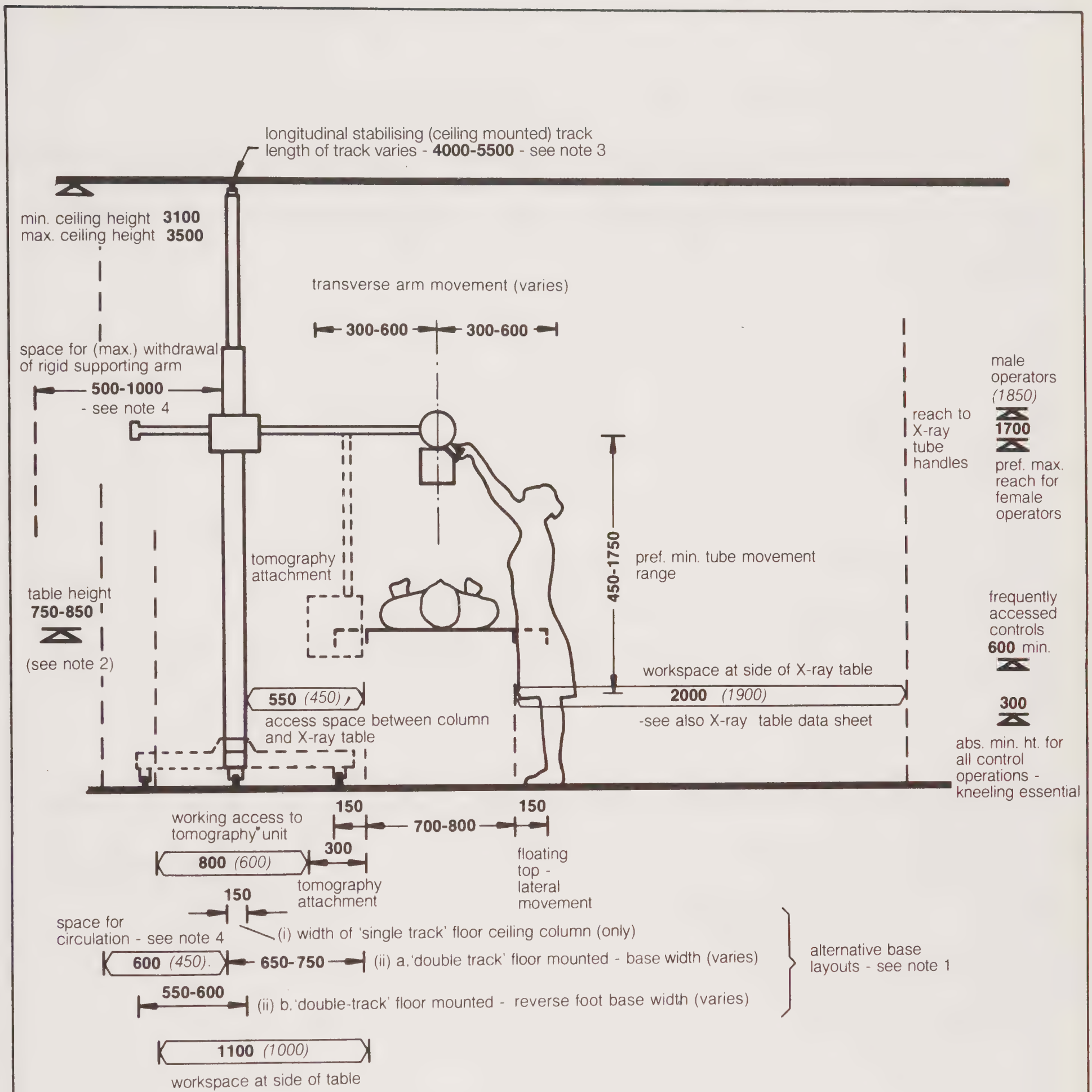
5. Additional space to pass head of patient trolley is desirable. Where this space is not available this procedure will be inconvenient for staff to use.

Activities:
General radiodiagnostic procedures

X-ray tube (2)

Floor/ceiling support
(with fixed or sliding or floating top table)

Users:
Radiographer and patient



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes).*

Notes:

1. Floor/ceiling columns are preferred to models which are floor mounted only. This is because they are more stable and present less obstruction to staff approach at floor level. (Ceiling mounted columns - see X-ray tube (3) and (4) - should however be employed whenever possible as they give all-round access to the patient and provide greater tube mobility, including lateral exposures from either side of the patient).

2. Table height and patient trolley height should be the same to assist patient transfer.

3. Both floor and ceiling track lengths vary depending on model, manufacturer and type of X-ray table used but are usually both between 4000-5500 long.

4. Clearance required for max. withdrawal of tube rigid supporting arm will usually be greater than basic space required for circulation past column support.

5. See also X-ray tube (1) and X-ray table data sheet.

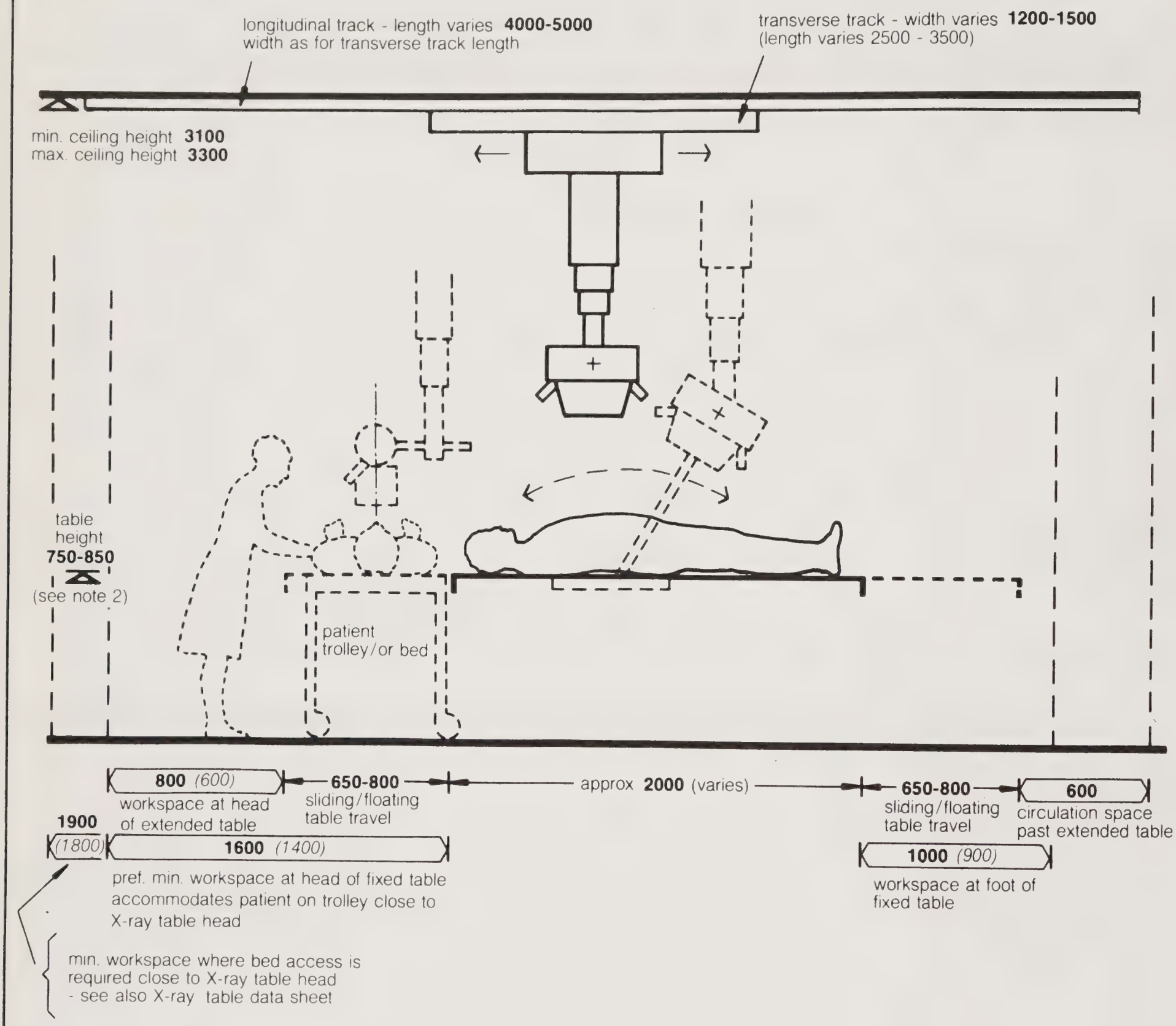
6. Operational experience indicates that overall room widths should preferably not be less than 5 metres.

Activities:
General radiodiagnostic procedures

X-ray tube (3)

Ceiling mounted support
(with fixed, or sliding, or floating top table)

Users:
Radiographer and patient



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes)*

Notes:

1. Ceiling mounted columns are generally preferred, because they leave the floor free of obstructions, give all-round access to the patient and provide full mobility for the tube over a required area, including lateral exposures from either side of patient.

2. Table height and patient trolley height should be the same for ease of patient transfer

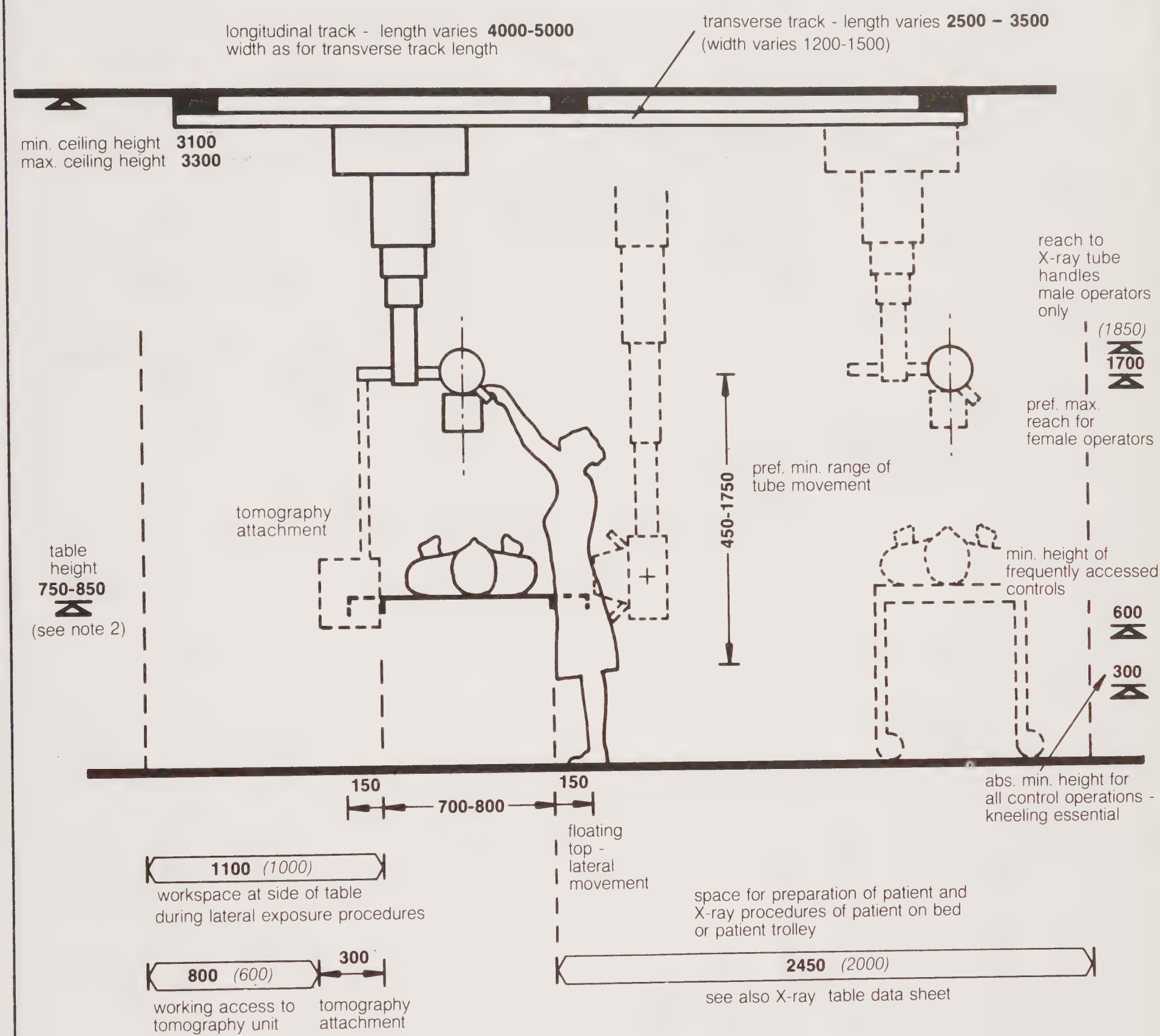
3. See also X-ray tube (4) and X-ray table data sheet.

Activities:
General radiodiagnostic procedures

X-ray tube (4)

Ceiling mounted support
(with fixed, or sliding, or floating top table)

Users:
Radiographer and patient



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes).*

Notes:

1. Ceiling mounted columns are generally preferred, because they leave the floor free of obstructions, give all-round access to the patient and provide full mobility for the tube over a required area, including lateral exposures from either side of patient.

2. Table height and patient trolley height should be the same for ease of patient transfer.

3. See also X-ray tube (3) and X-ray table data sheet.

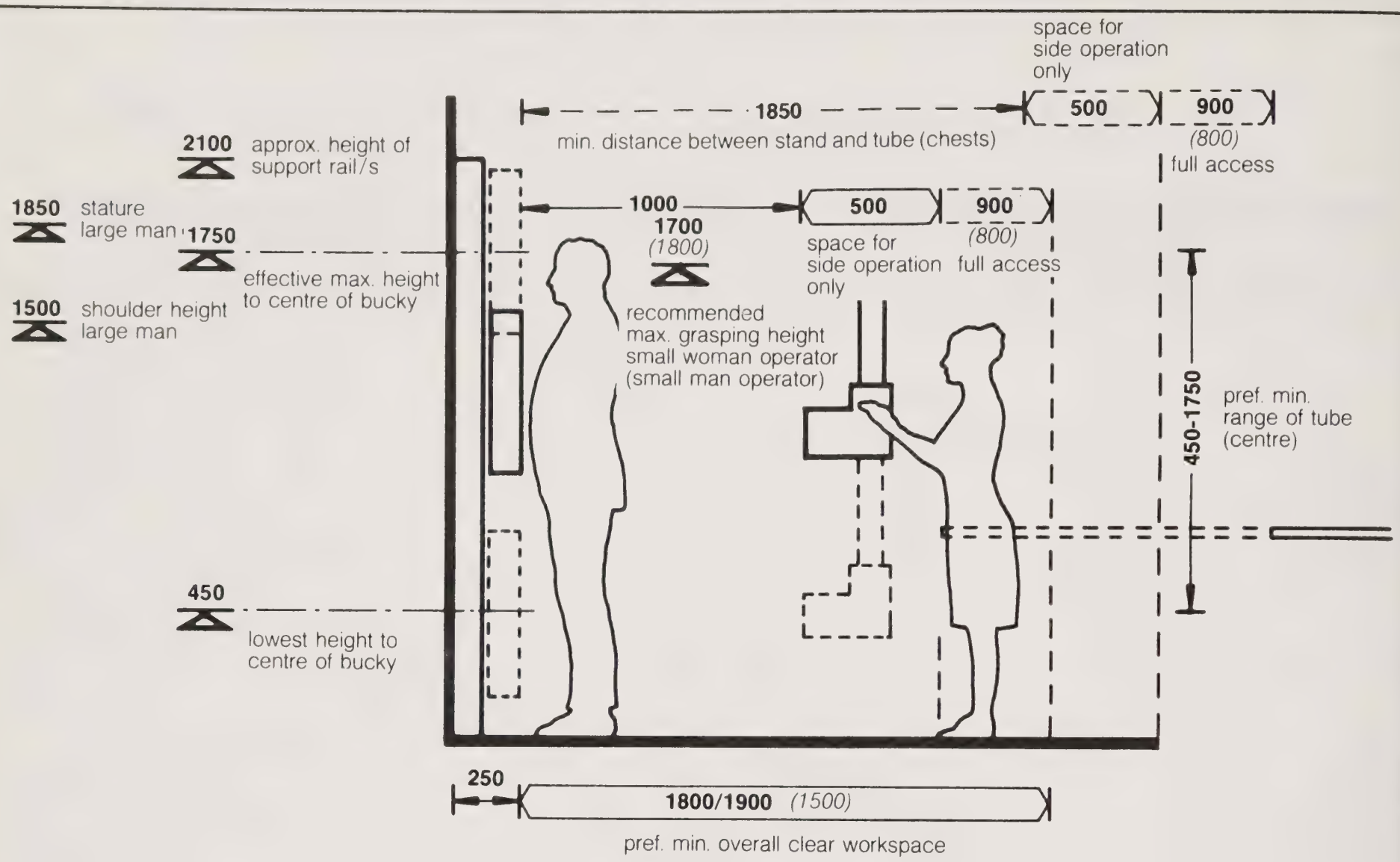
4. Operational experience indicates that overall room widths should preferably not be less than 5 metres.

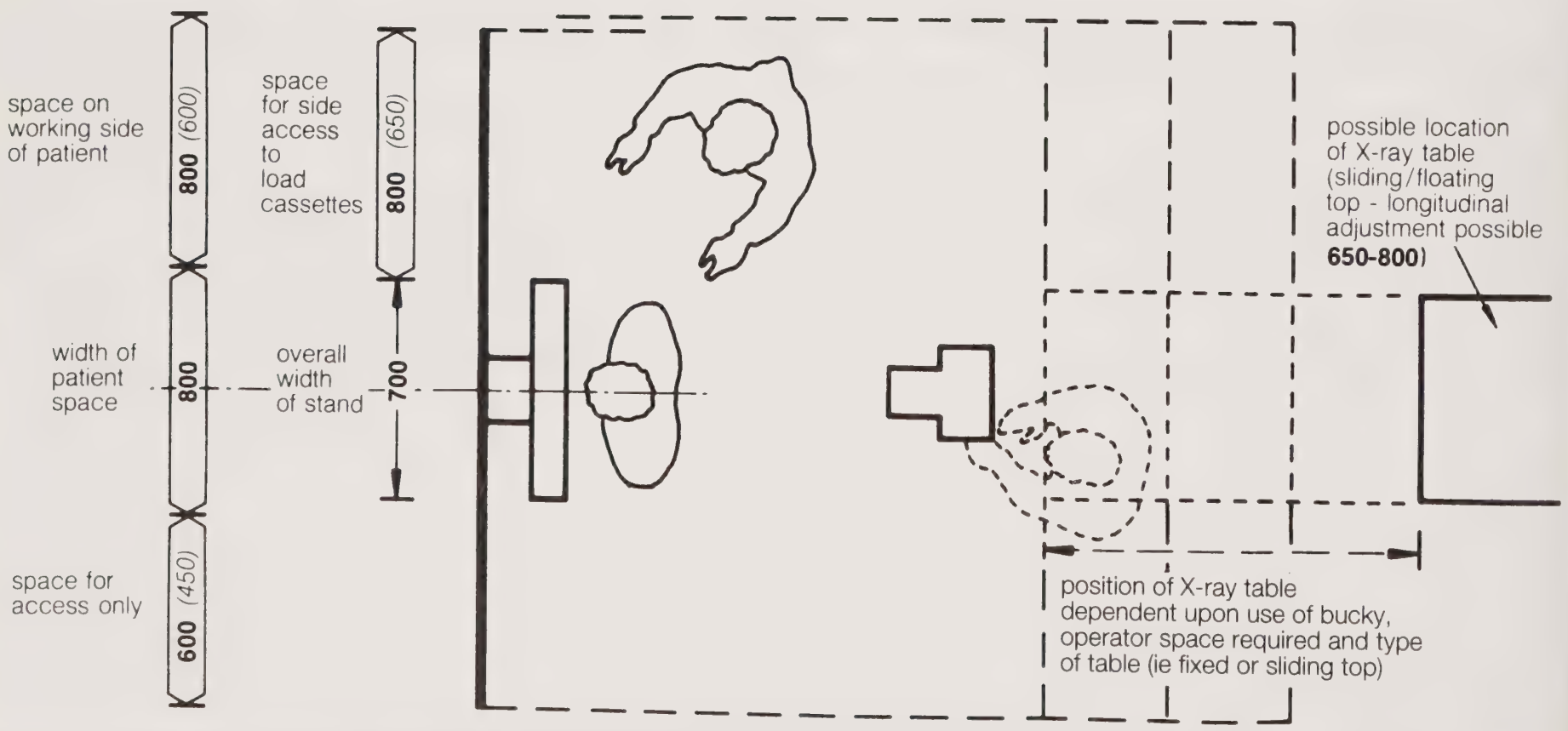
Activities:
General radiodiagnostic procedures. See also Bucky Stand (2) data sheet.

Bucky Stand (1)

Wall mounted/vertical

Users:
Radiographer and patient.





1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes)*

Notes:

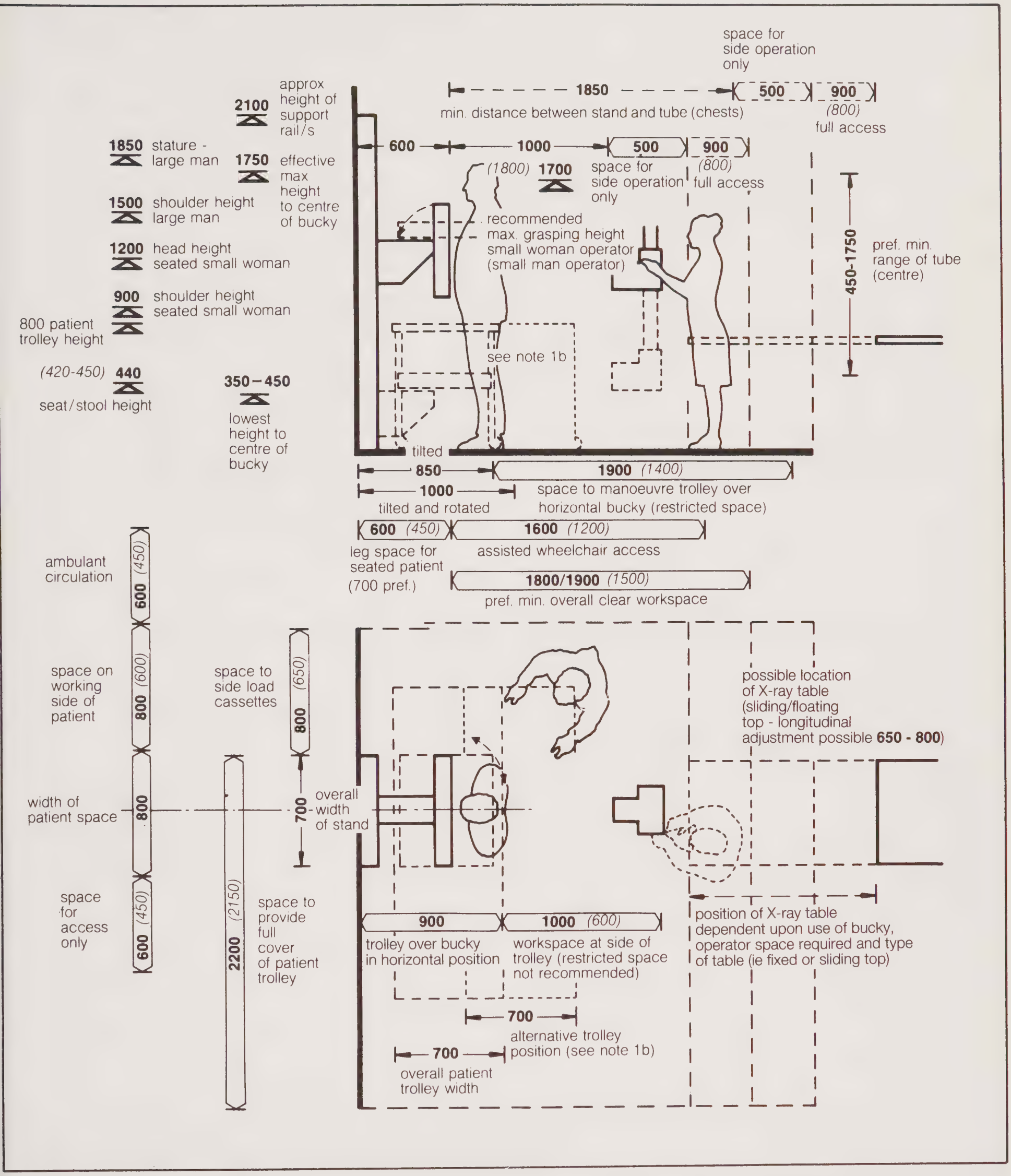
1. Examinations may be undertaken with the patient standing.
2. Workspace shown relates to 1000 distance between tube and stand.

Activities:
General radiodiagnostic procedures. See also Bucky Stand (1) data sheet.

Bucky Stand (2)

Wall mounted/universal

Users:
Radiographer and patient



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes)*

Notes:

1. Examinations may be undertaken with patient either:-

a) standing
b) seated on stool or chair
c) seated on edge of patient trolley
d) lying on patient trolley with bucky in horizontal position under trolley

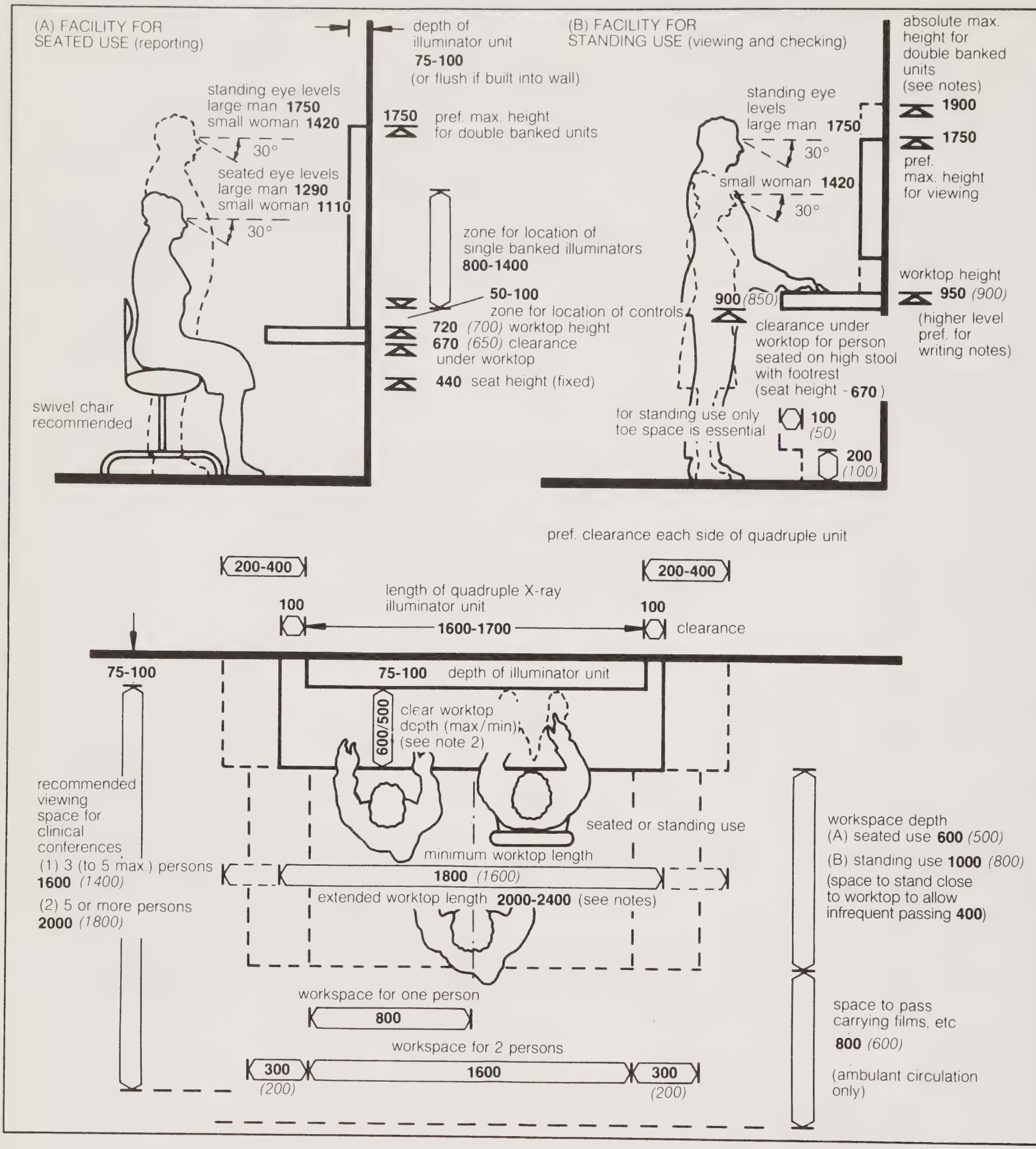
2. Workspace shown relates to 1000 distance between tube and stand.

Activities:
Viewing and reporting on X-ray films using single or double banked quadruple wall mounted X-ray illuminators

X-ray Illuminators

(reporting and viewing workstations)

Users:
Male and female staff



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes)*

Notes:

1. Double banked illuminators are recommended for convenience of use, but do present some design difficulties when positioned over a high worktop for standing use, where the upper viewers can be positioned too high for a large proportion of female staff and also shorter male staff. It is therefore preferable that double banked illuminators be installed over worktops at the lower level of 900 above floor level (or designed for seated use). Even so the design of illuminator must be very carefully selected to ensure that the viewing area does not exceed the absolute limit of 1900 above floor level (eg to facilitate this, switches should be located either at the side of the units or incorporated into the design of the worktop to maximise vertical space immediately above worktop which is available for viewing).

2. Close viewing distance is 450 mm. therefore bench depth should be minimised. However, where large X-ray films and envelopes are handled, a minimum depth of 600mm is desirable. All worktops should therefore be 600mm deep (measures to front edge of illuminator).

3. A worktop width of 1600 provides 2 basic workstations only. For more efficient working additional holding space (pref. 400 mm) should be available to one side of each workstation. Optimum worktop length is therefore 2400 mm.

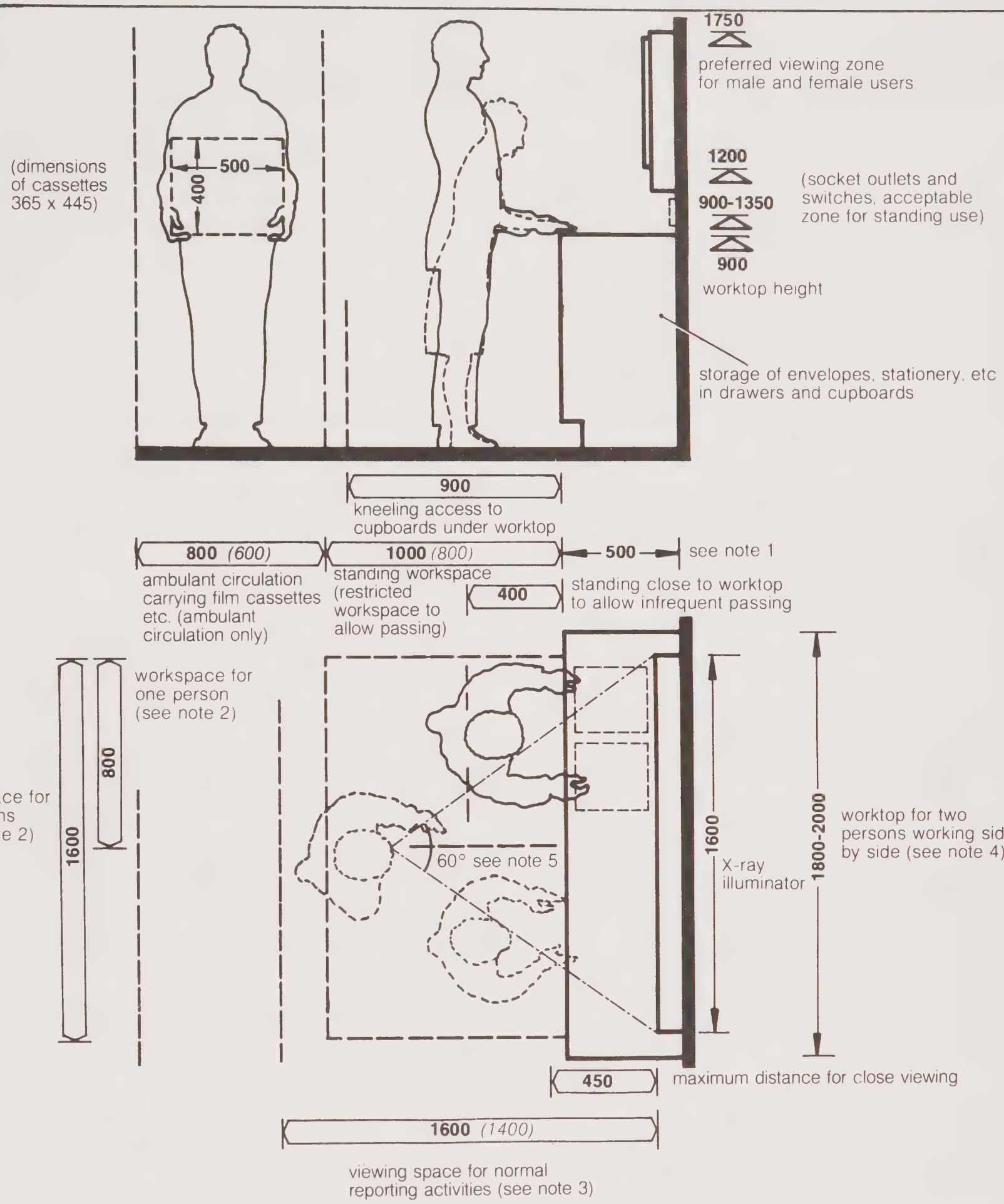
4. Recommended spaces for general viewing are based on focal length (acuity) of 1000 for older staff

Activities
Viewing and checking and reporting on X-ray films.

X-ray worktop

with wall mounted X-ray illuminators (viewing areas)

Users
radiography staff (male and female)



1350 *(1300)*

Preferred minimum: *Restricted minimum (not recommended for general use: see explanatory notes)*

Notes:

1. Bench depth is very critical. 500 minimum is required to hold large cassettes, films and envelopes. Any increase in depth would impede reach and approach to X-ray viewers for critical viewing. Therefore it is preferable that bench length be increased to provide bench-top space for incidental small items associated with film sorting and collating.

2. Workspace width (800 for one person, 1600 for two persons) provides unimpeded space for arm and hand movements during simple manipulative worktop tasks. Below elbow height (800), space required for access to worktop can be reduced to 600 and 1400 respectively (eg a low radiator or other projection could be accommodated within the lower periphery of the workspace shown).

3. This recommendation is based on the acuity (focal length of 1000) of older staff. Where large clinical conferences occur this space should be increased from 1600 (1400) to 2000 (1800).

4. A 1600 worktop gives 800 per workstation. 800 will accommodate 2 large film/cassettes only, and additional space of 100-200 is preferred to accommodate associated items (see note 1).

5. Recommended max. head movement when comparing 4 films.

Appendix 2

Description of radiological techniques

X-ray techniques

1. X-rays are generated in an X-ray tube by accelerating a focused beam of electrons emitted from a heated filament (the cathode) to impinge at high velocity on a target (the anode). The accelerating voltage between anode and cathode, which varies according to the techniques in use, is normally between 25 and 150 kilovolts. The X-rays are emitted from the small area of the target (the focal spot) which is bombarded by the electron beam. These rays have a high penetrating power and can pass through many substances including body tissues.

2. In their passage through the body, X-rays are partially attenuated, the extent depending on the nature and thickness of the tissues in the path of the beam. By placing a sensitive film (or other detecting device, as in CT scanning) in the path of the emergent beam, an image is formed of the body tissues in terms of their differing abilities to absorb the X-rays.

3. The rays which produce the film image emerge from the X-ray tube through a beam limiting device and are known as the useful beam. Additional radiation can also be present in the form of:

a. leakage from the X-ray tube housing;

b. scattered radiation, which is radiation generated by the interaction between the useful beam and objects in its path (including the patient) and is emitted in directions other than that of the useful beam;

c. residual radiation which, having passed through both patient and cassette, emerges in the direction of the useful beam.

Suitable measures must be taken in the building construction, and in the installation, siting, and use of X-ray equipment to ensure protection of all persons from unnecessary exposure to these forms of radiation.

4. The films used in radiography differ from those for most photographic processes in that they consist of a base coated on both sides with emulsion sensitive to light and to X-rays. When the X-rays irradiate a suitable material (usually rare earth phosphors) it fluoresces, and, to enhance or "intensify" the effect of the radiation, the sheet of X-ray film is held in close contact between two fluorescent surfaces known as intensifying screens; the emulsion is thus subjected to the influence of both light and X-rays. These intensifying screens are held with the film in a light-proof container known as a cassette; the largest in general use (holding films of 35 cm x 43 cm size) may at present weigh up to approximately 2.8 kg.

5. Another method of viewing radiographic images is via an Image Intensifier, a special type of vacuum tube with a TV camera. An electronic image is generated on the face of the tube and then amplified, giving a real-time display to be viewed on a monitor via closed-circuit TV. At the discretion of the operator (usually a radiologist) and by means of dedicated apparatus, the image of the intensifier may be recorded on film or on videotape. Such equipment is used in radiology departments for "screening" (fluoroscopy) procedures such as barium meals, positioning of catheters, etc. Conventional films using cassettes with screens may also be taken during such examinations without recourse to the Image Intensifier system: this provides better definition but the radiation dose is higher.

Medical ultrasound techniques

6. Ultrasonics have an important part to play in diagnosis, for example in obstetric, urological, ophthalmic, cardiological and other examinations. Ultrasonic diagnosis is based on the passage of ultrasonic waves through a patient and for medical purposes, the frequency used normally lies between 1 and 20 MHz, which is well in excess of the audible range. The energy is produced by a crystal, or series of crystals, of piezoelectric material actuated by a high-frequency generator. Ultrasound is not transmitted through air and a coupling medium is required between the transducer (the probe) and the patient. The levels of ultrasonic power used in diagnostic applications are low and, as far as is known at present, are not harmful.

7. Ultrasound is capable of passing through biological tissue and other matter where, for example, bone attenuates severely whereas muscle does so to a lesser extent. The speed at which ultrasound travels is dependent on the density of the material. When applied to the surface of a part of the body the ultrasound waves will penetrate until an interface of different matter is reached, when part of this energy is transmitted onward and part reflected.

8. By measuring the time delay between the transmitted pulse and reflected echo it is possible to display the depth of the interface on a cathode ray display. Multi-element and rotating transducers have opened up the field of "real-time" dynamic displays where, for instance, it is possible to display the movement of internal organs. Specific types of transducer are now available which are suitable for insertion into a patient.

Nuclear medicine imaging techniques

9. This procedure utilises radioactive isotopes, which are chemical substances artificially made radioactive with a relatively rapid rate of decay and suitable for administration to a patient, usually by injection. The substances used are emitters of gamma radiation and enable a survey of the organs in which they are absorbed to be made by detection of the emitted radiation in a gamma camera or a linear scanner. Different substances are used according to the organ(s) under investigation.

Computerised imaging

10. Computer technology is used to form various images of the patient's anatomy. The resultant image is viewed on a TV monitor screen and may be recorded on photographic film, hard disk, floppy disk, or magnetic tape. This image technology is fundamental to an increasing range of radiological techniques including computed tomography (CT), ultrasound and nuclear medicine imaging (NMI).

Appendix 3

Glossary

- **Actinic marking**

The process of permanent identification of an X-ray film (with required details such as a patient's name, date of examination etc) by a photographic method using light or X-rays. The use of light is by far the more common method and various systems exist for marking a portion of the film either within the cassette or outside it.

- **Anti-scatter grid**

Each "grid" is made up of very thin, evenly spaced lead strips separated by strips of plastic or other radiolucent material, either parallel or focused for a particular exposure distance. Placed between the patient and the film or image intensifier, grids allow the primary beam to pass easily but markedly reduce the scattered radiation, to improve image quality. The "grids" may be incorporated in the apparatus (see Bucky diaphragm) or they may be portable. The largest "grids" are typically about 43 cm square and weigh just over a kilogram.

- **Barium enema**

See Appendix 4.

- **Barium meal**

See Appendix 4.

- **Breast screening**

This is the national programme of population screening initiated by the Forrest report.

- **Bucky (Potter bucky) diaphragm**

A device whereby an anti-scatter grid is caused to move or oscillate during the exposure. This allows the anti-scatter function to be performed without an image of the grid being visible on the film. The term is usually abbreviated to "Bucky" and is used to refer not to the moving grid itself but to the assembly comprising a frame or holder containing the grid and having provision for the insertion of a cassette.

- **Capricode**

See paragraph 1.15.

- **Cassettes**

Light-proof containers in which X-ray films are normally placed prior to exposure.

- **CT scanning**

These initials stand for Computed Tomography. This technique enables detailed examination to be made of body sections. The method uses a moving X-ray tube coupled to special detectors which measures the absorption values of the body section under examination. Images are generated, held and manipulated by computer techniques.

- **CCTV**

Closed-circuit television is used in conjunction with an image intensifier/amplifier to carry out fluoroscopy and may also be used to transmit images elsewhere.

- **Chest stand**

An apparatus, designed to hold cassettes in the vertical plane and normally floor-standing with either ceiling or wall support, used for taking chest X-rays.

- **Cineradiography (cinefluorography)**

The process of recording on film or tape the fluoroscopic image of organs in continuous movement, such as the heart.

- **Component Data Base**

The Component Data Base consists of a series of Health Technical Memoranda which provide specification and design guidance on building components for health building which are not adequately covered by current British Standards. No firms or products are listed. The numbers and titles of the HTMs in the series are listed in the Bibliography.

- **Controlled area**

Any area where a person might receive a dose exceeding three-tenths of the annual dose limit for adult workers. Access to such areas is restricted and indicative notices must be displayed.

- **Diagnostic index**

An index of all examinations (or of selected examinations of interest) undertaken within a radiology department, filed according to the diagnosis. The filing may be according to the International Index of Diagnosis or to some simplified local format. The index may be kept on computer or on cards.

- **Digital Subtraction Angiography (DSA)**

This uses computer imaging technology to examine blood vessels by subtracting a control image from a subsequent image taken with the blood vessels filled with a contrast medium.

- **Endoscopic Retrograde Cholangiopancreatography (ERCP)**

An X-ray examination of the bile duct and pancreas performed with the aid of a flexible fibre-optic endoscope.

- **Examination table or couch**

The name given to the "bed" on which many X-ray examinations are undertaken. They may be simple fixed tables, those with fixed feet but with "floating" tops which move freely in all horizontal axes, those which elevate, those which tilt in one direction only, or the very sophisticated which tilt 90° in both directions and have tops which have independent extensive movement both longitudinally and laterally.

- **Film viewer**

See "Viewing box".

- **Filmless department**

A radiology department in which there are no permanent hard copies (for example films) of images, all data being stored, accessed and manipulated in digital form by computer techniques.

- **Fluoroscopy (screening)**

The use of X-rays to display images of internal structures or organs on a fluorescent screen. Such images are normally enhanced (by an image intensifier) for display on a monitor screen by CCTV.

- **Grid**

See "Anti-scatter grid".

- **High intensity film viewer**

Also referred to as "brightlight". This provides a localised source of high-level illumination. It can either be incorporated within a standard film viewer or be provided separately.

- **High voltage cables**

High voltage (HV) cables convey the electrical energy from the transformer to the X-ray tube. Cables to the under-couch tube (where one is present) can be mainly carried in underfloor ducting; those serving the over-couch tube are suspended from ceiling mountings.

- **Illuminator**

See "Viewing box".

- **Intensifying screens**

These are used singly or in pairs and consist of a fine layer of salts (usually "rare-earth") mounted on a thin card or plastic base. These salts fluoresce when excited by irradiation. The screens are fitted either inside a light-proof cassette or in a rapid film changer. The X-ray film is placed between them and thus the effect of the radiation on the film is intensified, reducing the exposure required to achieve a diagnostic image.

- **Interventional procedures**

A general term used to describe procedures involving the insertion of needles, probes, catheters, etc into patients with or without the injection of a contrast medium.

- **Intravenous urogram**

See Appendix 4.

- **Ionising radiation**

Ionising radiation is the part of the electromagnetic spectrum which is characterised by its property of ionising matter; examples are X-rays, gamma rays, electrons and protons, all of which have applications in medicine.

- **Lead equivalent (LE)**

The lead equivalent of a material is the thickness of lead that would absorb radiation to the same extent as the actual thickness of the material concerned, under specified conditions of irradiation. Lead equivalent is expressed in mm and is used as a measure of the protective properties of shielding materials.

- **Lead glass (protective glass)**

Glass which contains a high proportion of lead compounds and thus has a relatively high absorption of X-rays (that is, a relatively high lead equivalent for a given thickness) although transparent to light.

- **Lead rubber**

Rubber which contains a high proportion of lead compounds and is used as flexible protective material.

- **Lead rubber aprons**

An apron to protect the wearer against scattered radiation, which is worn when the operator needs to be outside the control cubicle when an exposure is made.

- **Lead rubber gloves**

Gloves made from lead rubber which protect the operator's hands from direct X-rays.

- **Light beam diaphragm**

A device used to illuminate the desired area of the patient for accurate positioning prior to radiography. It incorporates a centring illuminator and a set of lead "leaves" which ensure that during radiography the X-rays are confined to the illuminated area.

- **Magnetic resonance imaging (MRI)**

Images of anatomical structures which may be obtained by computing suitable signals which are obtained when a patient is placed in a strong magnetic field. The procedure is attractive because it does not involve the use of X-rays.

- **Mammography**

Mammography is the radiographic examination of the breast. In a District General Hospital it commonly refers to procedures undertaken upon clinical request, as distinct from breast screening programmes, for which special X-ray apparatus, special film and a dedicated processor are required.

- **Master index**

An index containing data referring to all patients examined within a radiology department. The data includes such details as the patient's name, address, age, sex and hospital number; it may in some instances be combined with the report index. The index may be kept on computer or on cards.

- **Multi-film viewer**

An apparatus comprising a number of movable electrically or mechanically operated panels which are capable of being placed in front of a fixed viewing box (commonly of light modules) so that multiple radiographs may be viewed sequentially.

- **Programme selector**

A control unit separate from the main X-ray console which is used with rapid film changers to preselect exposure programmes and table movement.

- **Radiation Protection Adviser (RPA)**

The Ionising Radiations Regulations 1985 require that a Radiation Protection Adviser be appointed by any employing authority where there is a likelihood of persons receiving significant radiation doses. It is required that he/she should be trained to certain standards. The adviser will usually be a physicist.

- **Radiation Protection Supervisor (RPS)**

This appointment is made by the Health Authority after consultation with the department head and the RPA (to whom he/she must, afterwards, have direct access). Each will have had special training for the post. Under the direction of the RPA, they will have day-to-day responsibility for protection arrangements in their area or department.

- **Radiation Safety Officer (RSO)**

Following the Ionising Radiations Regulations 1985, this title has been replaced by "Radiation Protection Supervisor".

- **Radiodiagnostic room**

A diagnostic room containing equipment which uses ionising radiation to produce images.

- **Rapid film changer**

An apparatus, usually electro-mechanically operated, designed to allow a sequence of films to be taken at variable speeds, usually used in angiographic procedures. While sometimes incorporated in an X-ray table, the apparatus is often separate. They can be used singly or in pairs and positioned in different planes (commonly known as bi-plane).

- **Remote control fluoroscopic apparatus**

This term applies to a type of fluoroscopic apparatus which can be completely operated by the radiologist from a remote console behind the protective screen.

- **Report index**

An index containing details of the examination request and radiologist's report; it may, in some instances, be combined with the master index. The index may be kept on computer or on cards.

- **Safe-lit area**

A safe-lit area is one from which natural and artificial light can be excluded by use of light-proof doors or partitions and which has photographically "safe" lights installed for use when required. This enables the area to be used for handling photographically sensitive materials in safe conditions when necessary, for example loading/unloading of film magazines.

- **Scatter (scattered radiation)**

Radiation which has been deflected from its original path and is a hazard both to film quality and to personnel.

- **Sialogram**

See Appendix 4.

- **Sinogram**

See Appendix 4.

- **Skull unit**

A type of X-ray apparatus which is designed specifically for cranial examination including cerebral angiography. In some cases a tomographic facility is also included.

- **Special procedures**

A composite term used to distinguish radiological examinations of more complexity (for example arteriography, DSA, sinography) from the more common investigations.

- **Supervised area**

An area where the dose received is likely to be more than one-tenth but less than three-tenths of the annual dose limit for adult workers. Such areas are common. There is no restriction of access but work in the area should be subject to an "agreed" scheme of work.

- **Tomography**

A radiographic technique designed to form a diagnostic image of a selected plane within the body. In conventional tomography (as opposed to CT scanning) the method used is to move the X-ray tube and the film in opposite directions during the exposure in such a manner that the desired plane is imaged sharply, but other planes are blurred. The movement is commonly linear, but more complex movements in two dimensions may be employed.

- **Trendelenburg**

A term used to indicate the head-down or adverse tilt of an X-ray tilting table. Such tables normally move from a vertical position through the horizontal to a varying degree of adverse tilt. The range of movement of an individual table is often shown, for example as 90°/30°, which would indicate

a vertical position in one direction and an adverse tilt or trendelenburg of 30°.

- **Ultrasound**

See Appendix 1, paragraph 6.

- **Videostore (memory device)**

A device incorporated in a CCTV system to memorise a stationary image during fluoroscopy. This can reduce the switched-on time of the X-rays and the exposure of the patient and staff. It is sometimes used in a single flash mode to replace radiography and to reduce the delay due to film processing, for example in operating theatres.

- **Viewing box**

Also referred to as a film viewer box or illuminator. An opal glass-fronted box evenly illuminated from the rear, on the face of which radiographs are clipped for viewing. Usually provided in multiples of 35 x 43 cm modules with switches or dimmers or both.

Appendix 4

Description of some common contrast media X-ray investigations

1. Radiological investigations can be divided into two main categories: those for which no dieting or other preparation is required, and those in which a combination of such preparation and administration of a contrast medium are involved.

2. Contrast media are substances which are both suitable to administer and which differentially absorb radiation compared with normal tissues. They have chemistry which makes them stay in place when administered, thus enabling the organ or system in which they are situated to be outlined. This technique is required when the part of the body under investigation has a similar density to its surrounding tissues and is not, therefore, readily visible on a plain radiograph.

3. Two of the commonest contrast materials in current use are barium (barium sulphate) and organic iodine compounds. Brief details of some investigations using these media are given.

Angioplasty

4. A similar procedure to arteriography (see paragraph 5) where the inserted catheter has an inflatable balloon near the tip. After insertion and localisation, the balloon can be inflated to distend narrowed arteries.

Arteriogram

5. The insertion of a guide wire through a needle into an artery and then, after removing the needle, the threading over this of a fine plastic tube usually referred to as a catheter. By the use of special guide wires and catheters, the tip of the latter can be directed into a wide variety of aortic and arterial branches. A water-soluble contrast medium is then injected, usually iodine, firstly in small amounts, to check the position of the catheter using an image intensifier screening technique. When a satisfactory position has been confirmed, the flow of a larger amount of contrast medium through a particular part of the body is demonstrated using quickly repeated X-ray exposures which are recorded by rapid film changing, or by other methods.

Barium enema – an examination of rectum and large bowel

6. Following appropriate bowel preparation, the colon is filled with barium via a rectal catheter. The radiologist will monitor progress on the TV monitor and take films as required. This part of the examination takes 5-10 minutes and may be followed by injection of air to enable "double contrast" studies to be made. The patient will then go to a conveniently adjacent WC to evacuate the barium, after which further films may be taken of the "empty" rectum and bowel. The patient may need to rest in the recovery room before this phase of the examination. The whole procedure usually lasts approximately 30 minutes, but may be longer in some cases.

Barium meal – an X-ray examination of the upper digestive system

7. Patients initially stand (whenever possible) between the vertical X-ray couch and the image intensifier. They then swallow the barium under the direction of a radiologist who watches the progress of the barium into the stomach and digestive tract on the monitor screen. In addition to the monitor image, of which a video recording can be made, the radiologist can also take "still" X-ray films when he wishes to record a particular stage in the investigation. The patient may be examined lying down as well as standing, and may be repositioned at intervals to help the radiologist obtain the best view of the suspected pathology. The procedure usually takes 15–30 minutes, although when progress through the lower part of the digestive system is also undertaken, a series of films may be required at intervals throughout the day and even 24 hours later.

Digital subtraction angiography

8. By digitising X-ray images and using computer techniques to subtract one image from another, it is possible to enhance the demonstration of blood vessels by removing background shadows. The injection may be intra-arterial or intravenous. It usually requires complex apparatus and powerful computer processing facilities.

Interventional radiology

9. Needles of differing sizes are inserted into specific structures to:

a. inject contrast media for diagnostic X-rays;

b. aspirate specimens for biopsy; or

c. inject or aspirate for therapeutic purposes. Usually a surgically clean procedure, but aspiration may unexpectedly produce dangerous organisms (see Sinography).

Intravenous urogram (IVU)

10. This is an examination of the urinary tract. After a preliminary film has been taken, a contrast medium is injected (usually into the patient's arm) and this enables the kidneys, ureters and bladder to be visualised on X-ray films. The examination involves a series of films being taken by a radiographer at timed intervals. Tomography (see Appendix 3) is often involved in this procedure. The total examination normally takes about an hour but can vary considerably from patient to patient.

Sialography

11. The insertion of a needle in the duct of one of the salivary glands in the mouth for the injection of a contrast medium to demonstrate that duct and its associated gland.

Sinography

12. The demonstration of the deep connections of an abnormal opening on the surface of the body. Almost invariably the track is heavily infected with dangerous organisms and precautions are required to prevent their spread.

Appendix 5

Radiology room floors

1. In the provision of floors for radiology rooms experience has shown that traditional construction consisting of a concrete slab or sub-floor with a screed of normal thickness fails to provide the required flexibility when installing interconnecting cables between items of equipment. This failure is most apparent when equipment is renewed, which can happen a number of times during the lifespan of a radiology department. The resulting disruption to the smooth running of a department when a floor has to be disturbed is well known.

2. There are a number of alternative methods which may be employed in the construction of floors in radiology rooms to increase flexibility and reduce disruption. The choice of a particular option should be carefully considered, bearing in mind the particular requirements of the project and the cost involved (see paragraph 3.41). One factor which should be borne in mind when choosing options 2 or 3 is that a greater depth is required for the floor construction. If, as recommended in paragraph 2.8, the radiology department is on the ground floor, this will not cause complications. If, however, the department has to be located on an upper floor, this can only be achieved at the expense of restricted storey height to the accommodation below. For protection of people on the floor below, the thickness of the structural floor slab or the concrete sub-floor must be discussed with the RPA.

3. The options which follow are listed in order of cost, with the most economical given first. The options are expressed in general terms; more detailed information is set out in the flooring document of the Component Data Base.

Option 1: Floors with increased thickness of screed (overslab)

4. This option incorporates an increased depth of floor screed with a perimeter ring cable duct from which connections may be made to the generator, equipment racks and control console, etc. In addition, there is a section of load-bearing modular access floor over the area in which it is anticipated that the X-ray table will be sited; a degree of flexibility is thus provided (see Figure 1).

5. In the event of equipment being enhanced or renewed, additional cable trunking risers may be teed into the perimeter duct.

6. The perimeter ring duct needs to have a clear internal height of 100 mm and would normally be constructed of galvanised steel with a suitable flush removable lid. The floor finish should be continuous and sealed, but have a welded inset to delineate the position of the floor duct and access points.

7. This type of floor would, therefore, consist of:

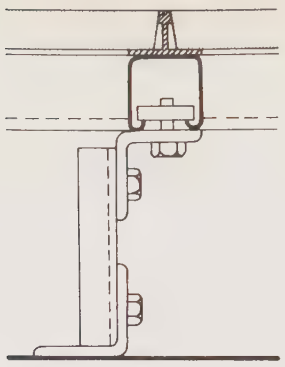
a. a continuous sealed floor finish;

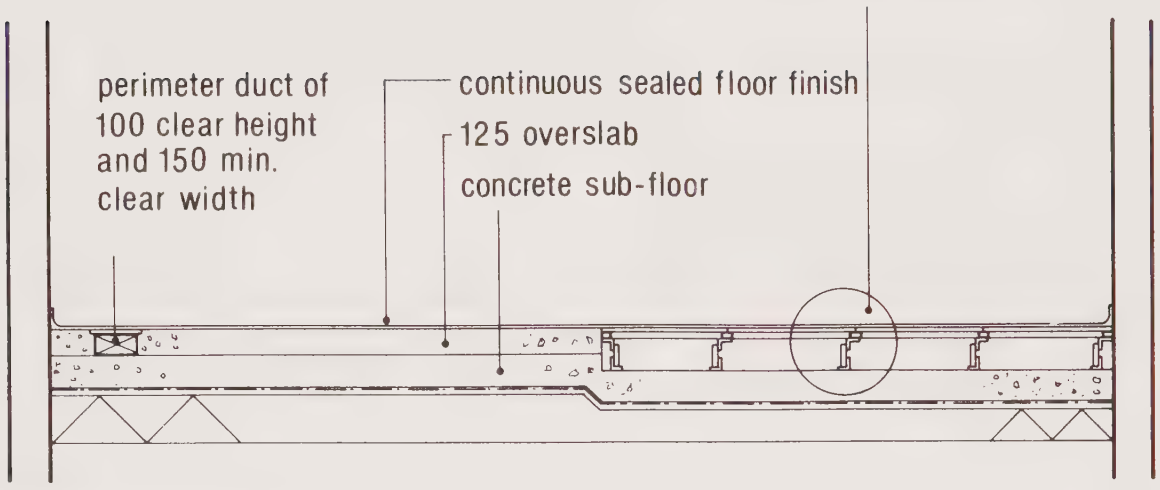
b. a minimum of 125 mm overslab of fine concrete (overslab is the term used by the Cement and Concrete Association for screeds in excess of 75 mm);

c. a separating membrane;

d. a structural floor slab or a concrete sub-floor.

8. The drying-out period for overslabs of this nature is significant and may well be in the region of 25 weeks. Account of this should thus be taken at an early stage in the construction programme. However, certain types of overslabs laid by specialist contractors offer substantially reduced drying-out periods (see Component Data Base).





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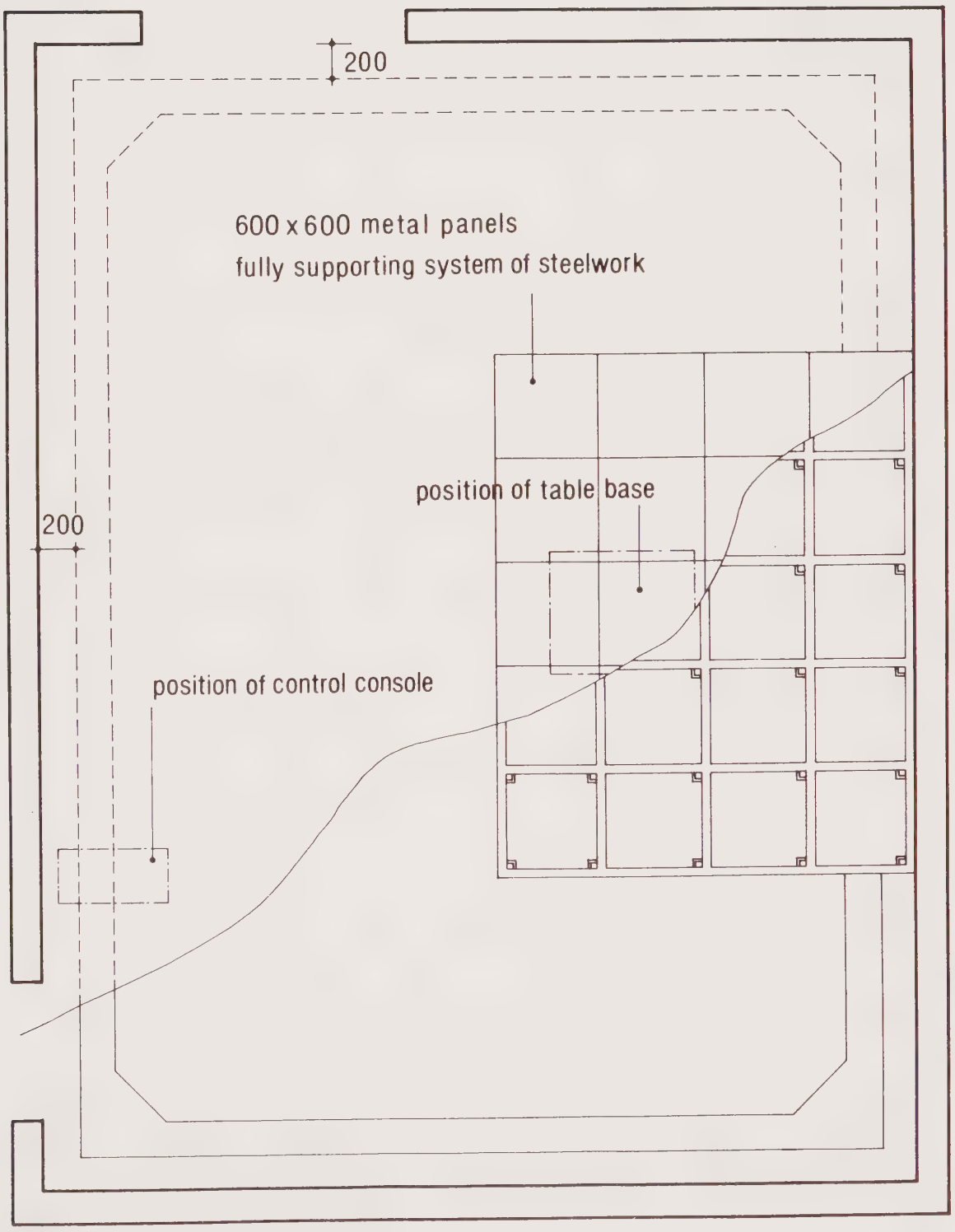


PLAN

Figure 1 Option 1: Floor with increased thickness of screed (overslab) and limited area of load-bearing modular access.

Option 2: Lightweight modular access floor

9. This option allows for a hollow floor which in principle offers complete flexibility for cable runs between radiology equipment and is similar in concept to a floor associated with a computer installation (see Figure 2).

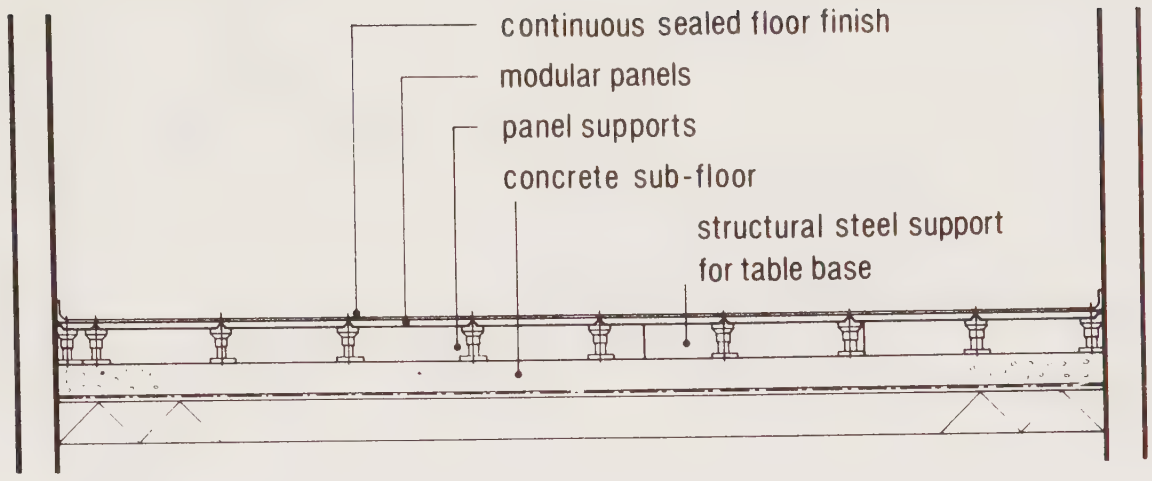
10. This type of floor would, therefore, consist of:

a. a continuous sealed floor finish;

b. a proprietary or similar modular access floor with a recommended clear depth of 200 mm formed with standard floor panels, normally 600 mm square, on adjustable screw-jack supports;

c. a structural floor slab or a concrete sub-floor with power-floated finish.

11. Attention must be given to the detailing of concrete or steel supports to carry the loads of the main items of radiology equipment, particularly the table. This will require a base plate necessitating the trimming of floor panels around it. It is particularly important to consider the movement of equipment during installation.



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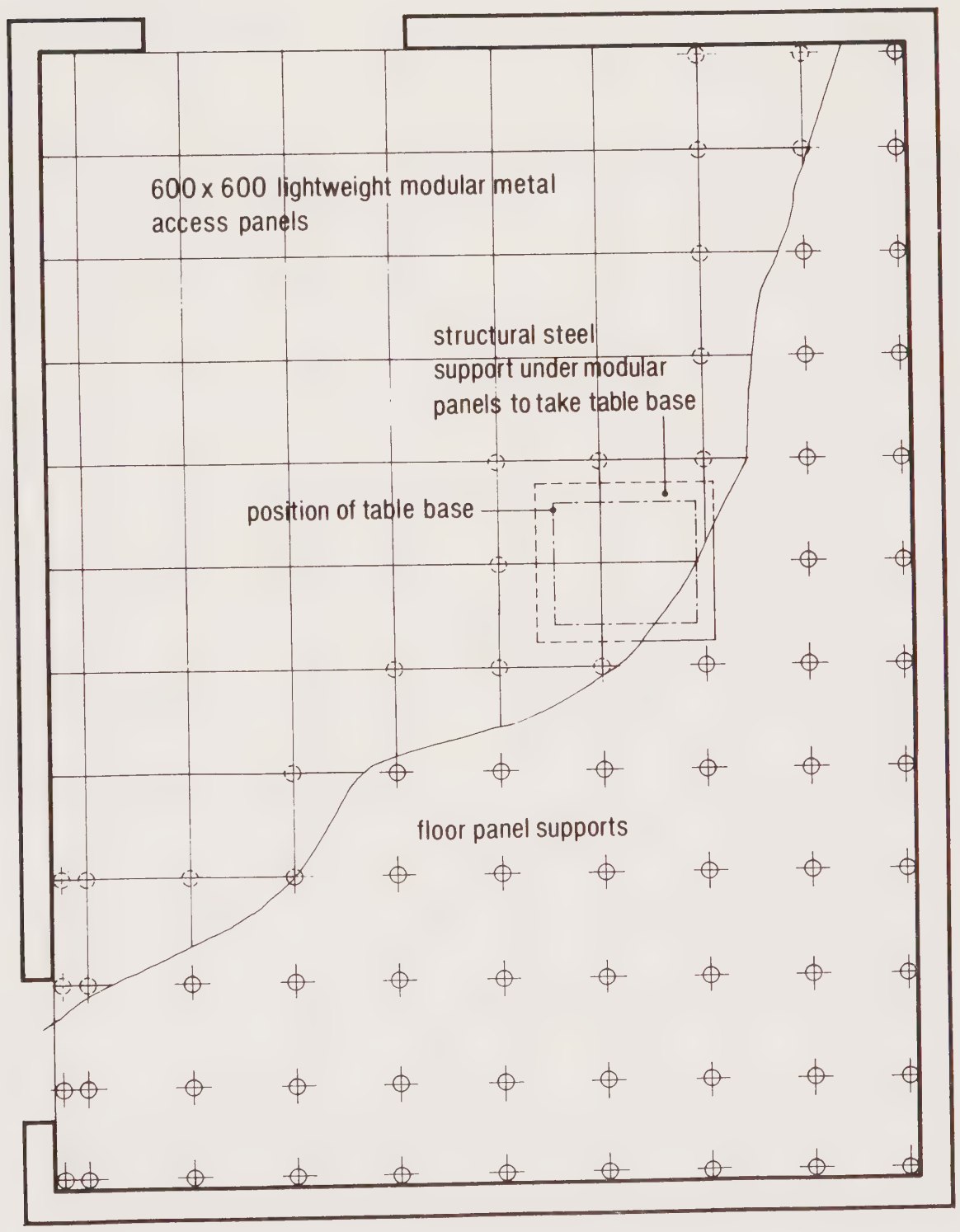


PLAN

Figure 2 Option 2: Lightweight modular access floor.

Option 3: Load-bearing modular access floor

12. This option offers the same facility of flexibility for cable runs as in Option 2, and in addition, due to its strength, allows for the weight of radiology equipment without additional supports (see Figure 3). This type of floor would, therefore, consist of:

a. a continuous sealed floor finish;

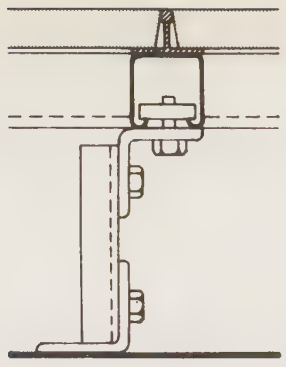
b. a floor sheathing, with structural metal panels;

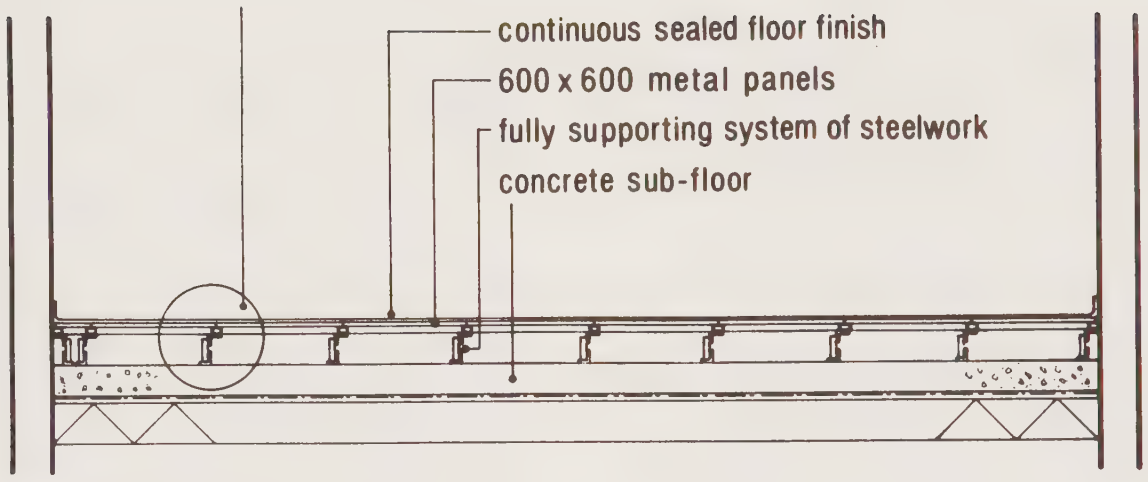
c. metal framework;

d. a series of supports;

e. a structural slab or a concrete sub-floor with power-floated finish.

13. This option is expensive.





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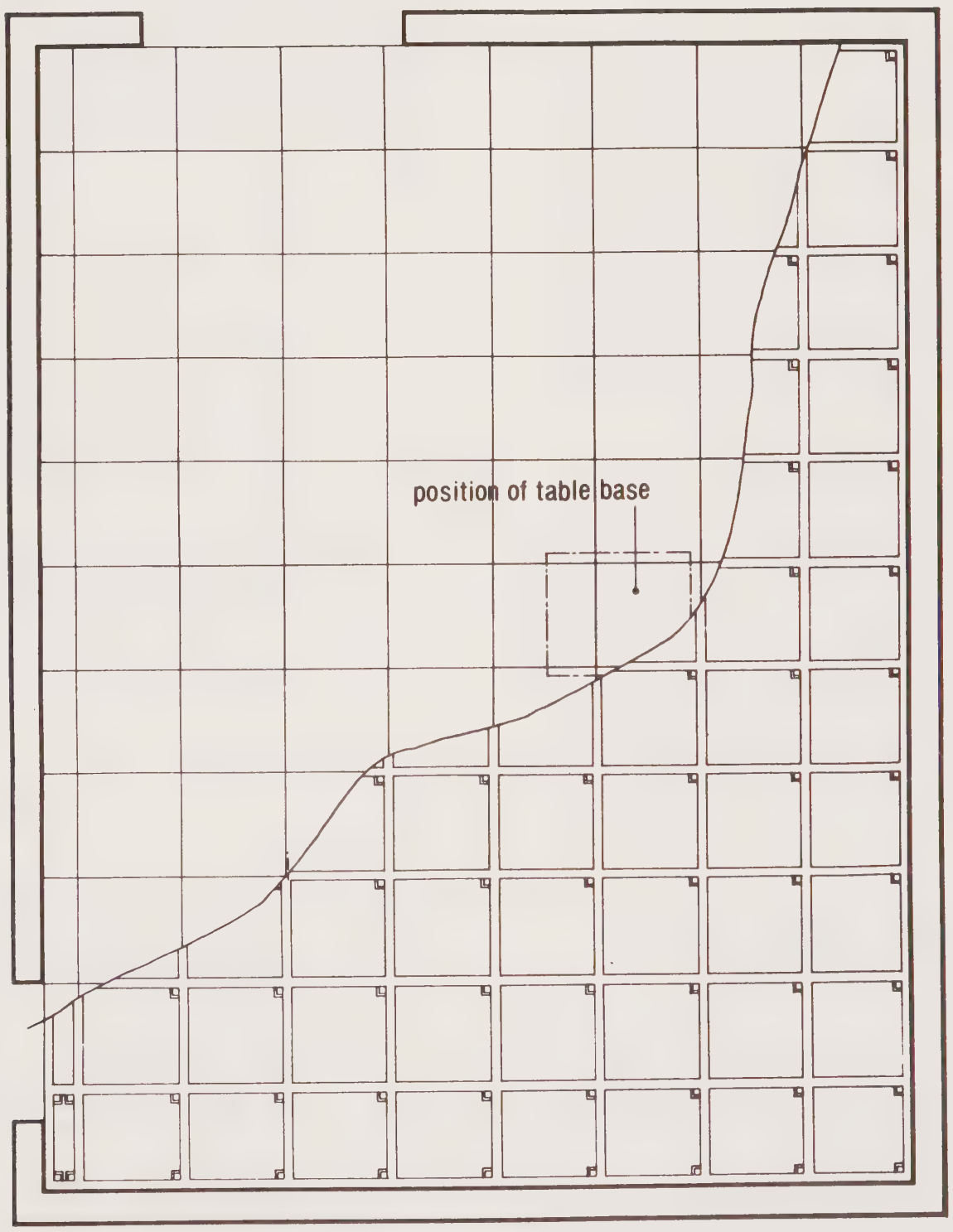

PLAN

Figure 3 Option 3: Load-bearing modular access floor.

Appendix 6

Statistical data

The information contained in this Appendix should assist the project teams in calculating future needs for radiology in their district. It is important that it should be read in conjunction with paragraphs 2.4 to 2.7 of this Note.

Values derived from research studies and surveys

1. Time per examination The average time taken to perform a single radiological examination has been variously calculated to be from 10 to 13 minutes. Departments undertaking a high proportion of simple procedures will have an average time per examination towards the lower end of this range and vice-versa. A high proportion of elderly and infirm or otherwise handicapped patients will tend to increase the average examination time.

2. Room utilisation The percentage of working time during which a diagnostic room can be in active use will vary according to the nature of the work being done. Authorities should plan from the outset to achieve the maximum utilisation of rooms. With this in mind it should be noted that a greater throughput may be obtained by centralising facilities, which also provides economy of building, staffing and equipment, while dispersed facilities are more likely to be under-used. An average occupancy factor of between 55% and 70% should be achievable.

3. Planned examinations per room per year
The number of investigations which can be performed in a diagnostic room varies considerably. At one end of the range, rooms dedicated to interventional procedures, which in some cases last several hours, may be used for less than 1000 examinations in a year. At the other end of the range are rooms used for very short-term procedures such as chest X-rays where as many as perhaps 12,000 examinations could be carried out. In practice many departments deal with anything between 5000 and 8000 examinations per room per year.

Number of examinations anticipated per year per 1000 of the catchment population

4. To determine the number of examinations anticipated per year per 1000 of the catchment population, it will be necessary for the project team to consider the spectrum of anticipated procedures to be undertaken together with the proposed work pattern and other radiology services, both existing and projected, within the catchment area. Korner statistics should be consulted, but reference to past records and the existing workload may also be made. Project teams should consult their professional advisers and obtain advice from the district statistician on the probable catchment population.

Formula for calculation of number of diagnostic rooms required

5. Project teams may wish to try out different sets of figures in the formula and test them in the light of their own circumstances, noting that small changes in the input figures may make large changes to the resultant number of rooms. The figures should be based upon good practice in a well-designed building using modern equipment, and thus may well show an improvement upon the throughput of an existing service, especially if the latter is not concentrated in one hospital.

6. To calculate the number of diagnostic rooms likely to be needed, the considerations described in paragraphs 2.4 to 2.7 should be taken into account. The values given to X, E, R and O below must be established by reference to local workload data. The following formula should be used:

$$N = X \times \frac{(E - O)}{R}$$

where N = number of diagnostic rooms

X = anticipated number (in thousands) of people in the catchment population to be served

E = number of examinations anticipated per year per 1000 of the catchment population to be served

R = planned average number of examinations to be carried out per year per diagnostic room

O = number of examinations done outside normal working hours.

Calculate R as follows:

$$R = \frac{(T \times U)}{M}$$

where T = working time available per year in minutes

U = average room utilisation rate (paragraph 2 of this Appendix)

M = average time per examination in minutes (paragraph 1 of this Appendix).

7. Worked example.

$$N = X \times \frac{(E - O)}{R}$$

Step 1 Determine from local statistics the anticipated number of people in the catchment population, that is, if population is 195,000

$X = 195$

Step 2 Determine from local statistics the number of examinations/year/1000 catchment population

Say $E = 480$

Step 3 Subtract the percentage of work undertaken outside normal hours, say 20%

20% of 480 = 96

$\therefore O = 96$

$\therefore E - O = 480 - 96$

$= 384$

Step 4 Calculate R as in paragraph 3.2

$$R = \frac{(T \times U)}{M}$$

Say T = 120,000 (= 250 days x 8 hours x 60 min)

U = 0.7 (= 70% utilisation)

M = 12 (minutes)

R = 7000

Step 5 $$N = X \times \frac{(E - O)}{R}$$

$$N = \frac{195 \times 384}{7000}$$

$= 10.70$

Say 11 rooms in this particular example.

Appendix 7

Radiology equipment

1. The function and physical characteristics of the individual items of equipment listed in paragraph 3.43 are summarised below.

2. The high-voltage transformer (generator) unit is designed to generate the high-voltage electrical energy required to produce the radiation from the X-ray tube. For certain applications a high voltage generator may be chosen which can be controlled by more than one console each equipped with all the selectors, displays and exposure controls necessary for making an exposure.

3. The control console has the full range of controls and facilities necessary to provide the radiological exposure factors for the equipment with which it is associated. Control consoles vary considerably both in size and weight. Modern design tends to reduce the overall dimension and weight of the control console by housing the more bulky elements in separate electronic equipment racks which are normally sited within diagnostic rooms.

4. Electronic equipment racks are used to:

a. accommodate the more bulky and complex control circuitry and allied parts of the high-voltage generating system which require easy access for maintenance;

b. accommodate the control circuitry and allied components of accessory equipment, for example CCTV or camera systems.

5. X-ray tube supports can be floor-to-ceiling or ceiling-suspended, with tracks as appropriate. The type chosen will depend on the radiological application. Care should be taken to ensure that the range of all the movements of the tube is sufficient for the techniques envisaged. The tube mounting must permit the X-ray tube to rotate about its long and short axes and around the vertical column. The facility to lock the X-ray tube rigidly in any selected angle at a preselected film focus distance is essential. The types of tube support are:

a. a floor-to-ceiling column which may be either static or movable on floor and ceiling track(s); it comprises a vertical column with a counterpoised cross-arm for the carriage of the X-ray tube and mounting;

b. a ceiling-mounted tube support comprising a vertical telescopic column suspended from a carriage assembly running on ceiling tracks longitudinally, laterally or both.

6. The X-ray tube comprises an "insert" (an evacuated glass envelope containing the electrodes – anode and cathode) fitted within an oil-filled cylindrical metal housing or "shield". The housing is lined with lead to reduce the emergence of unwanted X-radiation but has a port or "window" through which the useful X-ray beam emerges.

7. Other examination equipment. In addition to the basic X-ray generating equipment, individual rooms may be fitted with a range of purpose-designed examination tables, stands or ancillary apparatus, which may also incorporate a dedicated X-ray tube.

Note: Project teams are advised to consult manufacturers about the total heat emitted from all the diagnostic equipment assembled in each diagnostic room. In special procedures rooms the number of people involved in an examination will also influence the heat gain.

Appendix 8

Silver recovery

1. At the time of writing, "screen" type, double emulsion medical imaging films comprise some 65% of imaging film used in the NHS. These emulsions can contain between 5 and 10 gm per sq metre of recoverable metallic silver, depending on their manufacturer. The remaining 35% of imaging film is single emulsion photo-fluorographic film containing between 2 and 6 gm per sq metre of recoverable metallic silver, depending on the manufacturer.

2. As digital radiography and other similar advancements and small-film usage techniques come into general use, the percentage use of "screen" film types will decrease and the use of photo-fluoroscopic film will gradually rise. It is unlikely, however, that the use of screen film will entirely disappear for many years to come.

3. Approximately one-third of this metallic silver stays in the emulsion after processing to form the diagnostic image; a small proportion of the residue stays in the developer and the remainder is removed by the fixing solution. Most of this silver is in solution or suspension in the fixing bath and can be recovered by electrolytic means as almost pure silver by in-house recovery systems.

4. The silver remaining as the film's image can be recovered only when the film itself is removed from the archive store and sent to a commercial contractor having specialised recovery equipment.

5. It is essential to operate an efficiently managed silver recovery system. While silver recovery can provide a source of income to a hospital, the decreasing value and amount of silver used in current film emulsions, and the increasing cost of assay, commercial recovery and marketing of the metallic residues, can cause a reduction in this revenue. In order to maximise this income, it is necessary to manage the recovery process in such a way that a minimal number of assays are required and that the silver is stored securely and sent to the bullion market periodically.

6. The current-density electrolytic process is the commonest method used in the NHS, although the metallic replacement method can be used as a tailing system to remove the last remaining vestige of silver from the drained fixer solution.

7. In the high current-density electrolytic method, an electric current is passed through the silver-laden fixer between immersed electrodes (anode and cathode). Agitation of the electrolyte and movement of the cathode are used to enable the required high current-density to be maintained. The silver is deposited as a high-purity metallic flake on the cathode and is periodically removed. As the electrolysed solution is not contaminated by the process, systems in which the solution can be recirculated to the film processor may be used. This can reduce the consumption of new fixer by up to 50%. The cost of an installation is high in comparison with the metallic replacement method and electricity is consumed. However, there are no other consumables and the high-purity flake has a higher realisable value per gram of silver than that of the impure residue from the metallic replacement process.

8. In the interest of health and safety, silver recovery units should be located so that staff are not exposed to noxious fumes. Silver recovery units should not be sited in darkrooms. They may be sited in daylight film processing areas if the ventilation of these areas is provided in accordance with the guidance in paragraph 5.34 of this Note.

9. Where suitable commercial services are available, consideration should also be given to the collection and sale of used fixer solution in bulk when the storage of the fixer may be located outside the department, thus eliminating any processing area leakage of fumes from this source. The re-use of fixer is, of course, not compatible with this procedure.

10. There must be provision for the safe custody of recovered silver.

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Works Information Management System – a computerised information system for estate management tasks, enabling tangible assets to be put into the context of servicing requirements. *NHS Estates*

Option Appraisal Guide – advice during the early stages of evaluating a proposed capital building scheme. Supplementary guidance to Capricode. *HMSO*

Health Guidance Notes – an occasional series of publications which respond to changes in Department of Health policy or reflect changing NHS operational management. Each deals with a specific topic and is complementary to a related Health Technical Memorandum. *HMSO*

Health Technical Memoranda – guidance on the design, installation and running of specialised building service systems, and on specialised building components. *HMSO*

Encode – shows how to plan and implement a policy of energy efficiency in a building. *HMSO*

Firecode – for policy, technical guidance and specialist aspects of fire precautions. *HMSO*

Nucleus – standardised briefing and planning system combining appropriate standards of clinical care and service with maximum economy in capital and running costs. *NHS Estates*

Concise – software support for managing the capital programme. Compatible with Capricode. *NHS Estates*

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Printed in the United Kingdom for HMSO.
Dd. 295511 C16 10/92 C17647 ord 211286

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